A VIEW OF THE WEISNER QUARTZITE, NEAR CARTERSVILLE, GEORGIA

GEOLOGICAL SURVEY OF GEORGIA

W. S. YEATES, State Geologist

BULLETIN No. 14

A PRELIMINARY REPORT

ON THE

MANGANESE DEPOSITS

OF

GEORGIA

BY

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1908

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1908

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GEOLOGICAL SURVEY OF GEORGIA,
ATLANTA, Jan. 3rd, 1908.

To His Excellency, HOKE SMITH, *Governor, and President, Advisory Board, Geological Survey of Georgia.*

SIR: — I have the honor to transmit herewith, for publication, the report of Dr. Thomas L. Watson, formerly Assistant Geologist on this Survey, on the Manganese Deposits of Georgia. As is stated in Dr. Watson's Introductory, this work was done several years ago — a part while he was connected with the Survey, and the remainder, after he had severed his connection with the State's service. The exigencies of the Survey have necessitated a delay in publication. This, however, has robbed the report of little or none of its value; as the information collected is of both scientific and economic nature, having permanent value.

I recommend that this report be published as Bulletin No. 14 of the Geological Survey of Georgia.

Very respectfully yours,

W. S. YEATES,
State Geologist.

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INTRODUCTION

The field-study, which forms the basis for this report, was begun in September, 1900, and completed during the season of 1902. Only a part of the field-seasons, however, of each year, 1900, 1901 and 1902, were entirely given to this study. The work was begun late in the season of 1900, and was interrupted in 1901 by the writer's resigning his position on the Geological Survey of Georgia to accept the chair of geology in Denison University at Granville, Ohio. Returning to Georgia again in the early part of the summer of 1902, the remainder of the summer was given to completing the field-work on the problem.

For many years, Georgia has been one of the three principal producing States in the Union in manganese ores, her two strong competitors being Virginia and Arkansas. The first shipment of manganese ore from Georgia dates from the year 1866, when the total production was rated at 550 tons. These shipments were of ore mined in the Cartersville district, which district has yielded nine-tenths of the ore mined in the State. From the year 1866 to the present time, Georgia has been an important producer of manganese, the annual production varying somewhat widely, according to circumstances, from year to year.

The ores of manganese are entirely limited to the northern part of the State, distributed irregularly over parts of two geologically different areas, namely, the Paleozoic Group and the Crystalline Area. Of these, the commercially important deposits are wholly limited to certain areas in the Paleozoic Group. While a few tons of ore have been shipped, from time to time, from widely separated counties in the Crystalline Area, no workable deposits of the ore are known to occur in this area.

Since the distribution of the ores in the State is divided into two

geologically distinct and unlike areas, and since the mode of occurrence is somewhat unlike for the two areas, the ores are treated separately in this report, under (a) the manganese deposits of the Paleozoic Group, and (b) the manganese deposits of the Crystalline Area. Examination of the table of contents will indicate the general outline of the report, a summary of which it is unnecessary to repeat here.

Acknowledgments. — The writer wishes to make grateful acknowledgment of the uniformly generous aid rendered by many citizens in the State during the prosecution of the work. To the State Geologist, Professor W. S. Yeates, and to Captain John J. Calhoun, of Cartersville, Georgia, the writer's thanks are especially due for numerous courtesies. The many maps and published papers and reports of Dr. C. W. Hayes in the publications of the United States Geological Survey; the bulletins of the Geological Society of America; the Transactions of the American Institute of Mining Engineers; and the elaborate volume on "Manganese; Its Uses, Ores and Deposits," by Dr. R. A. F. Penrose, published as Volume I, of the Arkansas Geological Survey, have been constant sources of helpful information. The reports by Drs. Hayes and Penrose have been freely used in the preparation of certain parts of this report.

Granville, Ohio.

The Manganese Deposits of Georgia

CHAPTER I

DISTRIBUTION OF MANGANESE IN GEORGIA

The manganese ores occur in two geologically distinct areas in Georgia; one, the Paleozoic Group, which includes the ten northwest counties of the State; the other, the Crystalline Area, which comprises the Piedmont plateau and the Appalachian mountains provinces. The Crystalline Area, as shown on the map, opposite page 21, includes that part of the State, exclusive of the ten northwest counties, lying north of an irregular line, known as the "fall-line," which passes near or through the cities of Columbus, Macon, Milledgeville and Augusta. This line crosses the State in an approximate south or west course, and separates the Crystalline rocks from the Coastal Plain sands, gravels, clays, etc.

A somewhat irregular line, passing south from near Cohutta Springs, in Murray county, to the vicinity of Cartersville, Bartow county, and thence bearing south of west to Esom Hill, Polk county, and continuing west into Alabama, separates the Crystalline Area from the Paleozoic Group on the northwest. This line is known as the "Cartersville fault." These two provinces, the Paleozoic Group and the Crystalline Area, compose the north half of the State.

No deposits of manganese ore are known to occur in the Coastal Plain formations of Georgia, which compose the entire south half of the State, and have an areal extent, much greater than that of any single geological province in Georgia.

Considerable manganese mining has been done in the Paleozoic

Group, to which all the commercially important ores of the State belong. The ores of this area are conveniently grouped into two principal districts, namely, (a) the Cartersville district; and (b) the Cave Spring district. These include Bartow, Floyd and Polk counties, with isolated scattered deposits occurring in other counties within the limits of the Paleozoic Group.

Practically no mining has been done for manganese in the Crystalline Area. Fifty tons would probably be a liberal estimate for the entire output in manganese ores from this area. The ores of this area are usually impure and much scattered, and are rarely concentrated in quantity sufficient to be workable. While the ores of the Crystalline Area are not economically important, they have considerable scientific interest.

The ores of the Paleozoic Group occur in residual clays, derived from the decay of several different formations, namely, the Weisner quartzite (Chilhowee sandstone of Safford); the Knox dolomite; and, to a less extent, the Beaver limestone, perhaps. The Weisner quartzite and the Beaver limestone are grouped as Lower Cambrian by the United States Geological Survey; while the Knox dolomite, at least the greater part of it, is placed, by the same authority, as Lower Silurian. While the Knox dolomite formation is not divisible on lithologic grounds, there are sufficient reasons, stated later in this report, for regarding the lower part of the formation as Cambrian and the upper portion as Lower Silurian. These formations are described in some detail in another part of this report.

The ores of the Crystalline Area show some variation in mode of occurrence from those of the Paleozoic Group. Most of them, however, occur in a residual clay, derived largely from the decay of the crystalline schists, which, though of doubtful exact age, can be designated in part certainly as pre-Cambrian.

With but few exceptions, the manganese ores of the two areas consist of the oxides of the metal. In several instances, ores of a different mineral type, have been found in the Crystalline Area. Manganese-bearing silicate minerals enter somewhat largely into the composition of many of the various rock-types composing the Crystalline Area. Wherever the manganese has been observed in

the residual decay of these rocks, it is, almost without exception, in the form of the oxides of the metal.

PREVIOUS DESCRIPTION

No published reports on the geology of the State were issued by the State Geological Survey previous to the administration of Dr. J. W. Spencer, formerly State Geologist; though a Survey had been maintained at different times for a period of years prior to the act of the Legislature, in 1889, reviving the office of State Geologist. Since the organization of the Survey, in 1890, considerable geological investigation has been done in North Georgia by both the State and the National Surveys.

In 1893, an extensive report on the ten northwest counties — (The Paleozoic Group) — by Dr. J. W. Spencer, issued from the press. This report treats of the different aspects of the geology of the Paleozoic area in some detail. In addition to the other economic deposits of the area, the manganese ores are described and discussed at some length. The deposits of the Cartersville district are given no space in the report. Dr. Spencer also makes brief mention, in the same report, of manganese ores occurring in the Crystalline Area near Mt. Airy, in Habersham county.

During the past twelve or fifteen years, the United States Geological Survey has done much areal geologic work in the northwestern part of the State. The areal geology of the entire Paleozoic Group, with the accompanying geologic and topographic maps, has been completed by the National Survey, and most of the work has been published in the Survey publications. During the prosecution of this work, Dr. C. W. Hayes, Geologist-in-Charge, has given special attention to the principal economic ore-deposits of the area, which have been the subjects of special papers published in the Bulletin of the Geological Society of America, and in the Transactions of the American Institute of Mining Engineers.

In his work on the manganese ores of Arkansas, Dr. R. A. F. Penrose visited the principal deposits of manganese in the Paleozoic area of Georgia, as well as the other principal ones in the United States and Canada. Dr. Penrose has described and discussed

these deposits at some length in his report on manganese, issued by the Arkansas Geological Survey.[1]

PRODUCTION AND VALUE OF MANGANESE ORES

The following tables, taken from the Mineral Resources of the United States, give the production and value of manganese ores of the numerous producing countries for a number of consecutive years.

Table I shows the production of manganese ores in the three principal producing States in the Union, and the total for the United States, from the year 1880 to 1899 inclusive. The remaining States mine but little manganese ore; the total output of these has been grouped together under one column in the table. The last column in the table gives the value of the total output in the United States for each of the years specified. The table indicates a decided decline in production for the three principal States, Virginia, Georgia and Arkansas. It further indicates, that the total production of manganese ores in the United States, for the year 1899, was less than 10,000 long tons, while, in 1886, the total output was more than three times the production for 1899.

[1] Manganese; Its Uses, Ores and Deposits; by R. A. F. Penrose. Ann. Rept. Geol. Survey of Arkansas, 1890, Vol. I, 642 pages. For a description of the Georgia Manganese deposits, see pages 417-430.

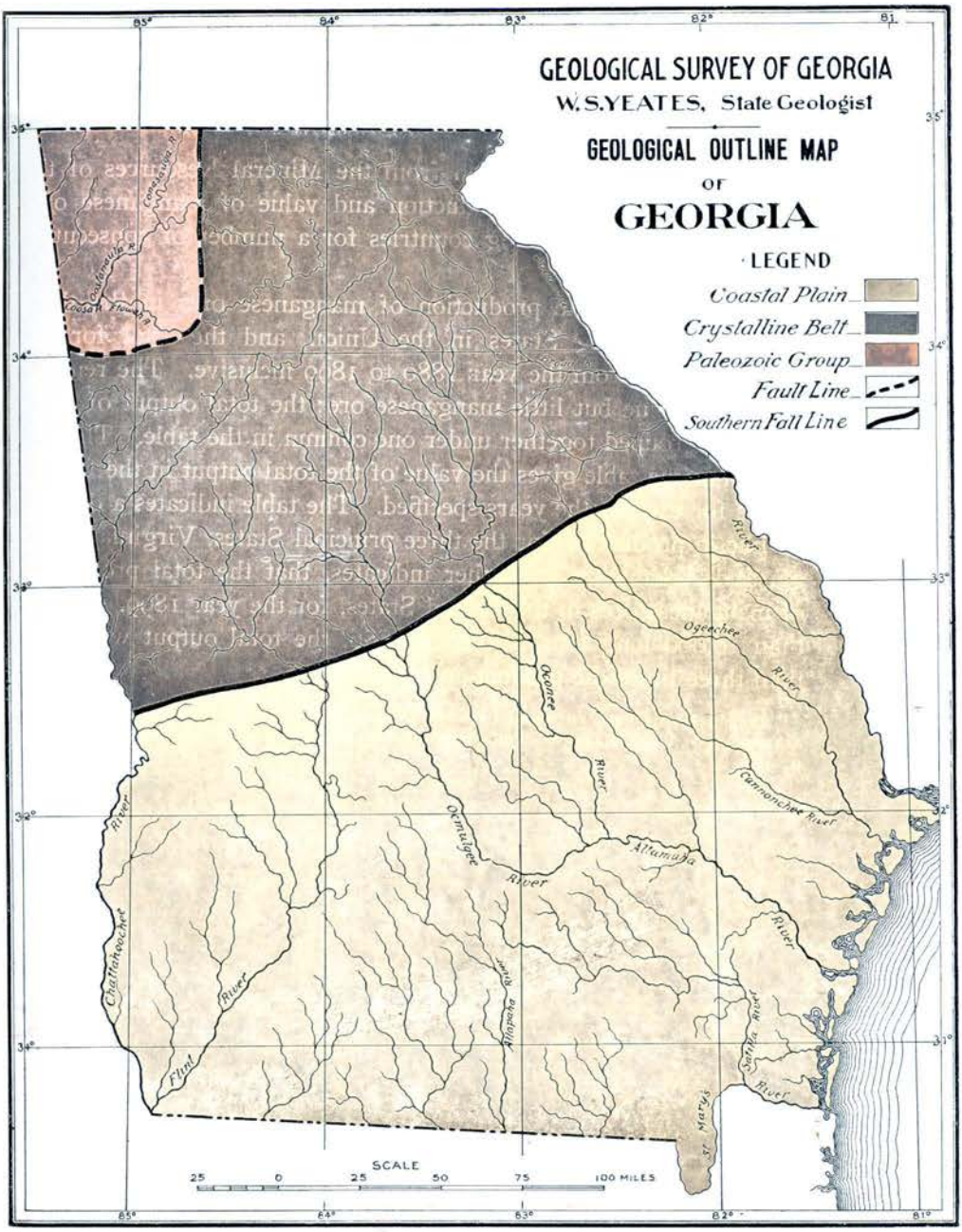

GEOLOGICAL SURVEY OF GEORGIA
W. S. YEATES, State Geologist
GEOLOGICAL OUTLINE MAP
OF
GEORGIA
LEGEND
Coastal Plain
Crystalline Belt
Paleozoic Group
Fault Line
Southern Fall Line
Chattahoochee River
Flint River
Ocmulgee River
Oconee River
Ogeechee River
Altamaha River
Satilla River
St. Marys River
SCALE
25 0 25 50 75 100 MILES

TABLE I

PRODUCTION OF MANGANESE ORES IN THE UNITED STATES FROM 1880 TO 1899 [1]

Year	Virginia *Long Tons*	Georgia *Long Tons*	Arkansas *Long Tons*	Other States *Long Tons*	Total *Long Tons*	Total Value
1880	3,661	1,800	——	300	5,761	$ 86,415
1881	3,295	1,200	100	300	4,895	73,425
1882	2,982	1,000	175	375	4,532	67,980
1883	5,355	——	400	400	6,155	92,325
1884	8,980	——	800	400	10,180	122,160
1885	18,745	2,580	1,483	450	23,258	190,281
1886	20,567	6,041	3,316	269	30,193	277,636
1887	19,835	9,024	5,651	14	34,524	333,844
1888	17,646	5,568	4,312	1,672	29,198	279.571
1889	14,616	5,208	2,528	1,845	24,197	240,559
1890	12,699	749	5,339	6,897	25,684	219,050
1891	16,248	3,575	1,650	1,943	23.416	239,129
1892	6,079	826	6,708	——	13,613	129,586
1893	4,092	724	2,020	882	7,718	66,614
1894	1,797	1,277	1,934	1,300	6,308	53,635
1895	1,715	3,856	2,991	985	9,547	71,769
1896	2,018	4,085	3,421	564	10,088	90,727
1897	3,650	3,332	3,240	886	11,108	95.505
1898	5,662	6,689	2,662	944	15,957	129,185
1899	6,228	3,089	356	262	9,935	82,278
Total	175,870	60,623	49,086	20,688	306,267	$ 2,941,674

[1] Twenty First Ann. Rept., U. S. Geological Survey, 1899-1900, Part VI (Mineral Resources) page 131.

Table II indicates the amount and value, by countries, of the manganese ores imported into the United States during the year 1899. The total importation was 188,349 long tons valued at $1,584,528.

TABLE II

MANGANESE ORES IMPORTED INTO THE UNITED STATES DURING THE CALENDAR YEAR 1899 [1]

Country	Quantity *Long Tons*	Value
Russia, Black Sea	73,397	$598,644
Brazil	28,115	299,877
British East Indies	17,950	54,471
Chili	17,575	111,726
Cuba	16,359	221,785
Colombia	8,900	82,489
Turkey in Europe	8,310	61,241
Turkey in Asia	5,780	46,822
Japan	4,492	31,657
Greece	3,030	10,526
France	2,953	21,080
Germany	1,274	34,927
United Kingdom	134	6,697
Nova Scotia, New Brunswick etc.	78	2,586
Total	188,349	1,584,528

1 Twenty-first Ann. Rept., U. S. Geol. Survey, 1899-1900, Part VI (Mineral Resources), page 142.

In table III, the quantities and values of the domestic and the imported manganese ores, from 1889 to 1899 inclusive, are, for comparison, shown side by side. The total production for the eleven years in the United States was 157,571 long tons, valued at $1,418,-037, against 779,400 long tons of ore imported into the United States, and valued at $7,568,216. This is an average of nearly five times as much ore imported, as was produced in the United States for the eleven years, with an increasing percentage of importations denoted in late years.

TABLE III

RELATIVE QUANTITIES AND VALUES OF DOMESTIC AND IMPORTED MANGANESE ORES FROM 1889 TO 1899 [1]

Year	Domestic Production		Imports	
	Quantity *Long Tons*	Value	Quantity *Long Tons*	Value
1889	24,197	$ 240,559	4,286	$ 78,391
1890	25,684	219,050	34,154	516,900
1891	23,416	239,129	28,825	380,618
1892	13,613	129,586	58,572	840,811
1893	7,718	66,614	68,113	880,238
1894	6,308	53,635	44,655	432,561
1895	9,547	71,769	86,111	747,910
1896	10,088	90,727	31,489	250,469
1897	11,108	95,505	119,961	1,023,824
1898	15,957	129,185	114,885	831,967
1899	9,935	82,278	188,349	1,584,528
Total	157,571	1,418,037	779,400	7,568,216
Average	14,325	128,912	70,855	688,020

[1] Twenty-first Ann. Rept., U. S. Geol. Survey, 1899-1900, Part VI (Mineral Resources), page 162.

The World's production of manganese ores is given in table IV. It gives the production of manganese ores in various countries in the latest years, for which statistics were available. The countries which exported manganese ores to the United States are marked (*a*).

TABLE IV

WORLD'S PRODUCTION OF MANGANESE ORES [1]

Country	Year	Product in Tons
NORTH AMERICA		
United States	1899	9,935
Canada (*a*)	1899	1,581
Cuba (*a*)	1899	13,686 (b)
Newfoundland	1897	1,600
SOUTH AMERICA		
Brazil (*a*)	1899	62,178 (b)
Chili (*a*)	1899	36,996 (b)
Colombia (*a*)	1899	8,995 (b)
EUROPE		
Austria	1898	6,132
Bosnia and Herzegovina	1898	5,235
Hungary	1898	8,055
France (*a*)	1898	31,396
Germany (*a*)	1898	42,669
Greece (*a*)	1899	15,300 (b)
Italy	1898	2,955
Portugal	1899	4,130 (b)
Russia (*a*)	1899	376,445 (b)
Spain	1899	136,533 (b)
Sweden	1898	2,321
Turkey (*a*)	1899	38,305 (b)
ASIA		
India (*a*)	1899	77,348 (b)
Japan (*a*)	1899	6,370 (b)
Java	1899	910 (b)
OCEANIA		
New South Wales	1898	1
New Zealand	1898	217
Queensland	1898	67

a Countries so marked contributed to the manganese supply of the United States n 1899.
b Exports.

[1] Twenty-first Ann. Rept., U. S. Geol. Survey, 1899-1900, Part VI, (Mineral Resources), p. 162.

USES OF MANGANESE

Manganese is used for many different purposes; but probably nine-tenths of the ore produced at present is consumed in the manufacture of the alloys of iron and manganese, known as spiegeleisen and ferro-manganese, which are used in turn in the manufacture of steel. When in the form of pyrolusite, perhaps its next most important use is in the manufacture of chlorine, as an oxidizer. Smaller quantities of manganese are used for various other industrial purposes.

Doctor Penrose summarizes the most important sources of consumption of manganese as follows: —[1]

- **Alloys**
  - Spiegeleisen, Ferro-manganese ------ Alloys of Manganese and Iron.
  - Manganese-bronze ------ Alloys of Manganese and Copper with or without Iron.
  - Silver-bronze ---------- An Alloy of Manganese, Aluminum, Zinc and Copper, with a Certain Quantity of Silicon.
- **Oxidizers**
  - Manufacture of Chlorine
  - Manufacture of Bromine
  - As a Decolorizer of Glass
  - Leclanché's Battery
  - As a Preparation of Oxygen on a Small Scale
  - Manufacture of Disinfectants (manganates and permanganates).
- **Coloring Materials**
  - Calico-printing and Dyeing
  - Coloring Glass, Pottery, and Brick
  - Paints ---------- Green, Violet

The Georgia manganese is at present, mostly, if not entirely, consumed in the manufacture of steel, in the form of spiegeleisen or ferro-manganese, and, to a less extent, in bleaching processes.

[1] Manganese: Its Uses, Ores and Deposits. Ann. Rept. Geol. Survey of Arkansas for 1890, Vol. I, page 7.

It has been used in some quantity at all the principal steel manufacturing plants in the United States. During the early development, the Georgia ore was largely marketed in England, where it was used for various purposes.

METHODS OF MINING THE ORE

The nature of the ore to be mined in the Georgia area is one of irregular distribution, in the form of nodules and pockets, through residual clays, which range in thickness from twenty-five to more than one hundred feet. The manganese distribution in the clays varies greatly, and the deposits are limited both in depth and lateral extent; hence, the methods for operating in one place will necessarily vary more or less in detail from those in another. As a rule, the deposits are located on the summits and higher slopes of the hills and ridges; though there are many exceptions; for they not infrequently occupy the lower slopes and valley bottoms.

The method of mining will depend largely upon the location of the deposit and its depth below the surface. Open-cut and pit, shaft and tunnel work are employed in mining the Georgia ores. The three are often used together to advantage in the same place, especially where the ores begin at or near the surface and continue irregularly to some depth below. In such cases, open-cut and pit work is used; and, from the bottom of the open work, shafts are sunk and drifts are run at different levels from the shafts. Tunneling becomes necessary in most of the steeper slope deposits. In the lower deposits, especially those of the valley bottoms, shafting and tunneling is most advantageously employed. In most of the tunnels and shafts it becomes necessary, from the nature of the clays, to timber the openings in order to prevent caving. The timbering over most of the Georgia area has been poorly done; and, in many cases, it has been put in to meet only temporary needs. This entails unnecessary expense, when, for some reason, mining is stopped for any considerable length of time in those openings in which the ore is not exhausted; as caving usually results, and the débris must be removed on resuming work.

From the nature of the deposits, mining on a large scale necessitates moving from one place to another, as the supply of ore is

exhausted; hence, permanent mining plants in any one place should be avoided. Expensive machinery is unnecessary, and the equipment should be as light and portable as possible. This insures easy moving, at a small cost, from one place to another. Besides, extravagance should be carefully guarded against; such, for instance, as the erecting of elaborate buildings and the purchasing of heavy and unnecessary machinery. In order that profits may result, the capital should be judiciously placed in the actual working of the ore below the surface, and not in the erection of expensive plants above ground.

PREPARATION OF THE ORE

The occurrence of the ores in the residual clays means, usually, more or less admixture of the ore with clay. As a general thing, the only treatment of the ore necessary before shipping, is to free it from the adhering clay. The larger masses can often be shipped without preparation, as the small quantity of adhering clay is not sufficient to materially lower the quality of the ore. Most of the ore, however, is of such a character, that, unless freed from the clay before shipping, it is rendered unmarketable. Crushing and jigging are necessary in the spongy or porous type of ore, the numerous cavities of which are filled with the clay; also, in those ores containing considerable free quartz grains and enclosed fragments of the rock. This is true of much of the breccia ore, which is rendered marketable by materially reducing the amount of siliceous material in this way. Washing will usually suffice for cleansing the bulk of the ore; but, in the case of the crushed and jigged ore, subsequent washing is also necessary.

In the early history of manganese mining in Georgia, less care was taken to properly cleanse the ore than at present, and much of the ore then shipped contained large quantities of adhering clay and other extraneous material. The principal, and frequently the only treatment was screening. At that time, the washing was done by hand. The form of washer used was a revolving cylinder perforated with holes, fed inside by a constant stream of water. The ore was put into the cylinder through a door; the door was closed and the cylinder was revolved by hand, until the ore was freed from the clay by running water; the ore was then removed through

the same opening. The capacity of the washer was very limited, and it could be used only on a small scale. Again, much of the smaller ore was lost through the perforations; but the larger pieces of ore remaining inside were thoroughly cleansed.

Later, a form of log-washer, similar to that used for cleansing the brown iron ores, was introduced; and this is the form of washer at present in use. Briefly, the log-washer consists of a long and stoutly built box, several feet in depth, and elevated at one end. A log, or central shaft, from twenty-five to forty feet long, with heavy iron blades spirally arranged along the log, revolves slowly in the box. The ore is fed at the lower end of the box, and is gradually forced by the revolving log, which is operated by steam, to the upper end, where it passes out. A constant stream of water plays on the ore during this operation; and the continuous agitation and beating of the ore by the log in running water frees it from the adhering clay. Plate VI presents a view of a modern washer equipped with jigs, on the Milner-Harris place, five miles northeast of Cartersville.

SIGNIFICANCE OF "FLOAT" ORE

The term, "float ore," is applied alike by miners in the Georgia districts, in the case of manganese, iron, or bauxite deposits, to scattered fragments of loose ore found over the surface. It is usually regarded, though not always, as a means of locating ore-bodies, and as indicating the character of the ore contained in the deposit, from which the "float" has travelled. This may or may not be a safe guide, since it must necessarily depend upon a number of conditions. It has been followed at times, when the search for ore proved entirely fruitless. The loose scattered fragments represent the original smaller disseminated ore particles concentrated into larger masses and scattered over the surface, upon advanced weathering of the parent rock; or, they may represent original fragments of the ore, not present in workable quantities, distributed through the rocks and exposed or scattered upon the surface, on decay. In this way, the amount of "float," scattered over the surface at any given place, may, as it sometimes does, represent the sum total of ore, both on

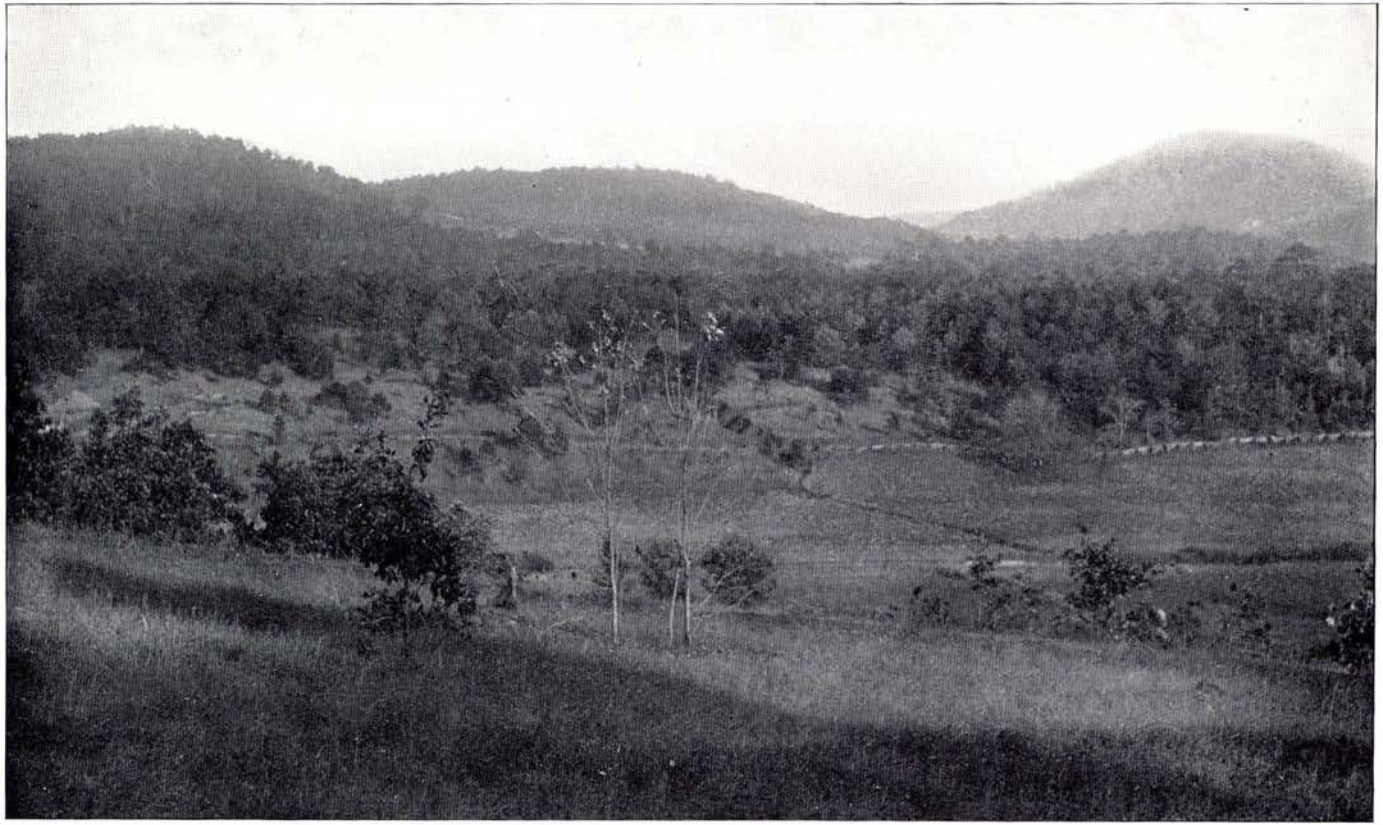


Photo by Thomas L. Watson.

A VIEW SHOWING THE RIDGE-VALLEY TYPE OF TOPOGRAPHY IN THE CARTERSVILLE DISTRICT, GEORGIA

and below the surface. A little ore may be found beneath the surface, or it may be absent altogether.

In cases where "float ore" is derived from outcrops of workable deposits, careful examination should be made before excavation work is begun. The workable deposits of Georgia manganese ore are usually located on the slopes and summits of the ridges; and the fragments loosened from the exposed deposit, would naturally be scattered in time, not over the outcrop, but further down the slopes, and finally in the valley bottoms. The outcrops may eventually be entirely covered by the wash and creep of loose rock particles from the higher levels, leaving no clue as to its location. The train of "float" may then have passed below and considerably beyond the limits of the outcrop.

CHAPTER II

THE MANGANESE DEPOSITS OF THE PALEOZOIC AREA

Resume of the Geology of the Area [1]

Position of the Area.—The position of the Paleozoic area is shown on the accompanying map.[2] The area includes the ten northwest counties of the State; and it is separated, on the east and south, from the Crystalline Area by the Cartersville overthrust fault. It forms a part of the southern extension of the great Appalachian Valley, southwestward into Middle Alabama.

Topography.—The region, as defined above, is a long, narrow belt, in which the valley type predominates, and whose axis has a general northeast-southwest trend. When viewed in detail, it is observed to be composed of numerous subordinate valleys separated by more or less extensive parallel ridges, whose axial directions are coincident with the general trend of the Valley province. This ridge-valley type of topography bears a definite relation to the rock structure of the area. The ridges mark the lines of more resistant rock, while the valleys are etched out of the soft shales and limestones. According to the character of the rocks composing the ridges, and the position of the beds with respect to the horizon, the ridges are high or low, rather broad and flat-topped, or narrow and sharp crested. The Knox dolomite, one of the most persistent formations in the area, and one of intermediate hardness, forms a

[1] For a detailed description of the geology of this region, the reader is referred to the numerous excellent published papers and reports by Dr. C. W. Hayes, in the Bulletin of the Geological Society of America; the Transactions of the American Institute of Mining Engineers; and publications of the U. S. Geol. Survey. It is due to the thorough and excellent work of Dr. Hayes, that the geology of this region is so well known.

[2] Opposite p. 21.

plateau of moderate elevation (between 900 and 950 feet), whose surface is gently undulating and not marked by any sharp ridges or peaks.

Traces of at least three rather distinct base-level plains appear in the region. According to Hayes,[1] the highest and earliest one of these plains was probably formed during Cretaceous time, and the period of rest, during which the atmospheric forces were operative, is believed to have been much longer than that of the formative period of either of the subsequent plains. The present streams were revived from the recent uplift and they are now engaged in sinking their channels in the surface of the last base-level.

STRATIGRAPHY.—The rocks of this region range in age from Lower Cambrian to Carboniferous, and they include slates, limestones, shales, sandstones and conglomerates. No igneous rocks are so far known to occur within the limits of the area. The manganese deposits of the area are limited to the residual decay resting on and derived from only three of the formations, namely, the Weisner quartzite, the Beaver limestone, and the Knox dolomite. These formations are described in sufficient detail under the individual ore districts, and the descriptions need not be repeated here.

STRUCTURE.—The region is one, in which the strata have been thrown into great northeast-southwest folds, from horizontal pressure applied in a northwest-southeast direction. In addition to the folding, continuation of the same compressive forces resulted in fracturing and faulting the strata over most of the area. To the northwest of the Coosa valley, the area is one of open folds, and faulting is less conspicuous. Folds of the anticlinal, synclinal and monoclinal types are represented in many examples of northeast-southwest trending ridges, preserved in the harder and more resistant rocks.

In the region to the south and southwest of Rome, the structure is more complicated, largely by reason of the folding having been quite or entirely obliterated by subsequent faulting. The structure is further complicated by deposition overlaps and abrupt lithologic

[1] Sixteenth Ann. Report, U. S. Geol. Survey, Part III, 1894–'95, p. 553.

changes.[1] Two classes of faults, which differ materially from each other, characterize the area. These are designated by Hayes as (a) major thrust faults, and (b) minor thrust faults.[2]

The major thrust faults are characterized by great horizontal displacement and low inclination of the fault plane. Three faults of this type have been recognized and described by Hayes in this area; namely, the Coosa, the Rome, and the Cartersville overthrust faults. In the Cartersville fault, rocks of probable Algonkian age, and belonging to the Crystalline metamorphic area of the State have been overthrust upon Silurian rocks of the Paleozoic area. These faults bear no relation to the manganese deposits, and, therefore, they need not be more fully described in the present connection.

The minor thrust faults characterize the southern part of the area, especially to the immediate south of Rome and in the vicinity of Cave Spring. They are of the ordinary Appalachian type, and have an approximate north-south direction, intersecting the main axis of the region at angles of 30° to 40°, or thereabouts. In length, they vary from three to eight miles; and they cut the strata at close intervals into narrow strips forming monoclinals, which dip steeply toward the east. These faults result in long and narrow strips of underlying Conasauga shale, which form the narrow valleys penetrating southward into the Knox dolomite plateau.

For the reason that the two types of faults are seldom found intersecting each other, the faulting is inferred to belong to different and, therefore, distinct periods of disturbance.

The Cartersville District.

The area known as the Cartersville district is located in the southeastern portion of Bartow county, about fifty miles northwest of Atlanta. It derives its name from the town of Cartersville, the county-seat of Bartow county, located on the Western and Atlantic railroad, one of the leading towns in northwest Georgia. The position of the area is shown on the accompany map, Fig. 1, p. 44,

[1] Geology of a Portion of the Coosa Valley in Georgia and Alabama. Bull., Geol. Soc. Amer., 1894, Vol. V, p. 472 *et seq.*

[2] Overthrust Faults of the Southern Appalachians. Bull. Geol. Soc. Amer., 1891, Vol. II, pp. 141–154. *Ibid*, 1894, Vol. V, pp. 465–480. Sixteenth Ann. Rept., U. S. Geol. Survey, Part III, 1894–1895, p. 557 *et seq.*

GEOLOGICAL SURVEY OF GEORGIA

W S. YEATES, STATE GEOLOGIST

TOPOGRAPHIC MAP OF

CARTERSVILLE DISTRICT GEORGIA

U S GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

GEORGIA
CARTERSVILLE SPECIAL MAP

84°38'15" 34°21'19" 45' 40' 84°38'43" 34°21'19"

SIXTH PINELOG

CASSVILLE

WOLFPEN

CARTERSVILLE

STAMP CREEK

ALLATOONA

EMERSON

BELLS

HARBINS

PLAY

Pinelog
SALLACOA
Rocky Branch
Little Pinelog Creek
Pinelog Creek
Little Pinelog
Pinelog Creek
BARTOW CO.
CHEROKEE CO.
Pinelog Mountain
Sugar Hill
Bear Mtn
Hanging Mt
Little Pinelog Mountain
Cartersville Poor Farm
Gudgers
Grassy Hollow
White
Grassdale
Nashville, Iron and Belt R.R.
Big Spring Branch
Wolfpen Gap
Brushy Knob
Creek
Stamp Creek
Holly Spring
Pellit
Louisville
Rowland Spring
Carter
Stamp Creek
Boundary Line
Boston
Corbin
Creek
Double Springs
Laffingal
Mc Kusky
Pine Mt
Cartersville
Copper Furnace
Stamp Creek
River
Seven Islands
Etowah
Western
Atlanta
Webster Ferry
Island Mills Ferry
Signal Mt
Emerson
Barton
Allatoona
Pumpkinvine Creek
Clark Creek
Payne

Scale 1/62500

Edition of Aug. 1906.

1 0 1 2 3 4 Miles

1 0 1 2 3 5 Kilometers

Contour interval 20 feet.

Datum is mean sea level.

ENGRAVED MAY 1907 BY U.S.G.S.

H.M. Wilson, Geographer in charge.
Topography by E.S. Ela, Geo. H. Guerdrum and C.C. Bassett.
Triangulation by U. S. Coast and Geodetic Survey.
Surveyed in 1903 and 1905

TRUE NORTH
MAGNETIC NORTH

APPROXIMATE MEAN DECLINATION 1903.

which covers more than 150 square miles, nearly equally divided between the Paleozoic formations on the west and the older crystalline, metamorphic rocks of the Piedmont plateau and the Appalachian mountains, on the east. The irregular line separating the two groups of formations marks the position of the Cartersville fault.

TOPOGRAPHY OF THE CARTERSVILLE DISTRICT

Examination of the map[1] indicates that, with respect to surface configuration, the district is divisible into two nearly equal, unlike areas. The line separating the two surface areas is fairly well defined; and is an irregular one. It approximately parallels the position of the Cartersville fault, and is located from one to three miles west of the fault line, and it marks the contact between the Weisner quartzite and the Beaver limestone. That portion of the district, north of the Etowah river and west of a line drawn northeast through Cartersville, consists of a rather smooth plain, etched out of the soft shales and limestone of Cambrian age. Its average elevation above mean sea-level is between 800 and 900 feet. Irregular hills and minor ridges rise 100 to 125 feet above the general surface of the plain, in places. Westward, the plain grades into the Knox dolomite plateau, a slightly more resistant magnesian limestone, whose general average elevation is but little above that of the Cartersville plain.

Beginning with and including the long north-south central band of Weisner quartzite, that part of the mapped area to the south of the Etowah river and east of the plain already defined, is a second area, whose surface is higher than and in marked contrast with that of the Cambrian plain described. The larger portion of this area forms the northwest extension of the Piedmont plateau. Its general surface elevation will average less than 1,000 feet above mean sea-level, with numerous irregular hills and ridges, that rise over all of its parts several hundred feet above the general plateau surface. The surface, then, is an irregular one, trenched by comparatively deep and narrow stream-channels, in many places cut through the thick covering of decayed rock into the hard rocks beneath. The

[1] See map, Fig. 1, p. 44

northeast corner of the area forms the equivalent lowering portion of the Appalachian mountains, showing elevations of from 1,800 to 2,000 feet. This marks the roughest surface area in the district.

The higher and more roughened surface of the eastern half of the mapped area is etched out of geologically old, highly tilted and disturbed metamorphic crystalline rocks, whose age, for the most part, is pre-Cambrian. The rocks were derived in part from original igneous masses, and in part from original sedimentaries.

The entire area covered by the map is well watered. Its drainage is through nearly north-and-south flowing streams, tributary to the Etowah river, the master stream of the region, which flows in a general westerly course, passing within a short distance south of the town of Cartersville.

PRODUCTION

The accompanying table gives the production of manganese ores in the Cartersville district, from the time they were first mined in 1866 to 1888. This district has been, from the beginning, the principal producer in the State; but complete data are not at hand for giving the separate production since the year 1888. The Cave Spring district, to the southwest of the Cartersville district, has produced considerable ore; and separate returns for the two districts can not be obtained.

PRODUCTION OF MANGANESE ORES IN THE CARTERSVILLE DISTRICT FROM 1866 TO 1888[1]

Year	Production *Long Tons*
1866	550
1867	
1868	
1869	
1870	5,000
1871	
1872	
1873	
1874	2,400
1875	2 400
1876	2,400

[1] Mineral Resources of the United States, 1888, p. 127.

1877	2,400
1878	2,400
1879	2,400
1880	1,800
1881	1,200
1882	1,000
1883	——
1884	——
1885	2,580
1886	5,980
1887	9,024
1888	5,568

During the year just closed (1902), a conservative estimate of the total amount of manganese ores mined and shipped from the Cartersville district would be about 4,000 tons, distributed among the following producers: R. P. Morgan, Knight and Barron, W. Keys, B. C. Sloan, The Blue Ridge Mining Company, W. C. Satterfield (on the old Bartow property), and The Georgia Iron and Coal Company (Chumley Hill). Of these, Mr. Morgan and the Georgia Iron and Coal Company were the principal producers, more than three-fourths of the total production having been mined by them.

The disposition of the ores shipped during the year 1902 was as follows: About seventy car-loads of the ore were shipped to Lynchburg, Virginia, to be used for paint purposes; between seventy-five and one hundred carloads were shipped to Birmingham, Alabama, to be used in the manufacture of steel; and the balance was shipped in small lots to various parties, in different localities, for paint purposes. The small amount of ore mined and shipped from Georgia during the year 1902 was due entirely to the prevailing low prices, all during the year.

The only other shipments of manganese ores from the State, during the year 1902, outside of the Cartersville district, were a few carloads from the Lowe bank in the Cave Spring district, formerly worked by Major James M. Couper.

STRATIGRAPHY

The older crystalline igneous and metamorphic rocks of the Piedmont plateau and the Appalachian mountain provinces occupy the

east half of the area shown on the map.[1] The Paleozoic formations of the Appalachian Valley province occupy the west half of the mapped area. The line separating the two groups is an irregular one marking the position of the Cartersville fault, which is described below in some detail.

The succession of formations, in ascending order, on the west side of the Cartersville fault, is as follows:

Lower Silurian	Knox dolomite (cherty magnesian limestone).
Cambrian	Conasauga shale (olive clay shale, chiefly). Rome shale and sandstone (purple, white green and brown sandstone and interbedded sandy shale). Beaver limestone (blue siliceous limestone). Weisner quartzite (quartzite, coarse conglomerate and micaceous shale).

Except the Knox dolomite, all the formations shown on the map to the west of the Cartersville fault belong to the Middle and Lower Cambrian. The Knox dolomite is here included entirely in the Silurian, although strong reasons appear for grouping the lower portion of the formation with the Cambrian.

The Paleozoic Rocks of the Cartersville District on the West Side of the Cartersville Fault

THE WEISNER QUARTZITE

The Weisner quartzite is in contact, on the east side, with the Cartersville fault. The principal area of the formation occupies the middle portion of the map, in the form of an irregular band having an approximate north-south extension of fifteen miles, and varying in width from one to three miles. It is composed chiefly of a fine-grained quartzite, with occasional bands of a fine-grained conglomerate, and additional beds of fine-grained siliceous or micaceous shales. Wherever exposed, this formation shows evidence of intense folding, fracturing and crushing — structures, which are typically illustrated in plate III. The absence of satisfactory exposures, added to the complex folding of the beds, prevents an accurate estimate of its total thickness; but it is probably not less than 2,000 feet thick in this locality. Two smaller exposures of the quartzite, due to faulting, are shown near the western margin of the map.

[1] See map p. 44.

As yet, no fossils have been found in this formation; but its relations to adjacent formations indicate, without much doubt, its Lower Cambrian position.

Specimens of the Weisner quartzite, carefully collected by the writer from the different localities covering the entire area exposed in Georgia, were thoroughly mixed and prepared as one sample, which yielded on analysis by the N. P. Pratt Laboratory, Atlanta, for the Geological Survey, the following results:

	Per Cent.
Silica, SiO_2	90.36
Titanic Oxide, TiO_2	0.07
Alumina, Al_2O_3	1.52
Iron Sesqui-oxide, Fe_2O_3	0.57
Lime, CaO	0.27
Magnesia, MgO	0.27
Manganous Oxide, MnO	none
Soda, Na_2O	0.43
Potash, K_2O	0.16
Water, H_2O, at 100° C.	none
Water, H_2O, above 100° C.	0.31
Iron Disulphide, FeS_2	1.50
Barium Sulphate, $BaSO_4$	4.46
Total	99.92

THE BEAVER LIMESTONE

The main belt of the Beaver limestone lies along the western base of the Weisner quartzite ridges. A second, but smaller area of the limestone, extends from Grassdale southward to the line of the Western & Atlantic railroad, and is indicated near the western margin of the map. Exposures of the fresh limestone are rarely seen; since it is readily soluble, leaving an insoluble residue which has formed a thick mantle of deep red soil. The formation is readily traced, however, from the resulting residual red soil. Fragments of the quartzite, both fairly fresh and considerably weathered, from the adjacent high quartzite ridges on the east, are more or less admixed with the red soil derived from the limestone. The few exposures met with indicate a gray semi-crystalline magnesian limestone containing occasional masses of chert, becoming, as Hayes states, shaly in places. The thickness of the limestone could

not be accurately estimated; but Hayes states, that it is probably not less than 800 to 1,200 feet.

The Beaver limestone and Weisner quartzite are both of considerable importance as ore-producing formations in the Cartersville district, since a majority of the ore-deposits in the district are associated with these two formations. The deposits of manganese in this area occur with about equal frequency in the residual decay of the two formations.

THE CONASAUGA SHALES

Next above the Beaver limestone is the great thickness of the Rome and Conasauga shales.[1] The main outcrop of the shales occupies the northwestern part of the mapped area. A continuous band of the exposed shales extends southward from the main outcrop to the line marking the Cartersville fault. The southern half of the band, extending several miles in a north, south and west direction from Cartersville, is greatly widened.

Pettit creek, one of the principal streams in the area mapped, takes its rise in the Conasauga shales in the vicinity of Warford cross-roads, some ten miles north of Cartersville, and maintains its entire course southward to the Etowah river on the soft shales.

In lithologic character, the shales vary from even, fine-grained aluminous or clayey rocks, to somewhat massive siliceous limestones, with the aluminous type prevailing. Numerous exposures show layers of thin-bedded limestone with the shales. In color the shales vary from light drab and yellow to dark slaty blue; but, as a whole, they are best described as olive shales. The weathered shale is usually tinted red, of a much lighter shade than the deep red soils of the limestone; and the residual product from the two formations is easily distinguished. The shales are usually exposed at the surface as slight anticlinal folds or arches, breaking through the magnesian limestone of the Knox formation, and are otherwise much fractured and crushed from the effects of long continued and intense compression. The thickness of the Conasauga formation is between 1,500 and 3,000 feet.

[1] Oostanaula shales of Spencer.

The following analyses give a general idea of the chemical composition of the Middle Cambrian shales in this area.

	I	II
	Per Cent.	Per Cent.
Silica, SiO_2	55.02	52.82
Alumina, Al_2O_3	21.02	26.17
Iron Sesqui-oxide, Fe_2O_3	5.00	9.46
Iron Protoxide, FeO	1.54	——
Magnesia, MgO	2.32	1.08
Lime, CaO	1.60	trace
Soda, Na_2O	0.81	0.20
Potash, K_2O	3.19	2.71
Water, H_2O at 110° C. (hygroscopic)	2.44	0.23
Water, H_2O above 110° C. (combined)	5.65	7.00
Titanic Oxide, TiO_2	0.65	——
Phosphorus Pentoxide, P_2O_5	0.06	——
Manganous Oxide, MnO	trace	——
Barium Oxide, BaO	0.04	——
Strontium Oxide, SrO	trace	——
Lithia, Li_2O	0.03	——
Sulphur Tri-oxide, SO_3	0.02	——
Chlorine, Cl	trace	——
Carbon Dioxide, CO_2	0.83	——
Carbonaceous Matter	0.32	——
Total	100.54	99 67

I. Middle Cambrian Shales. Coosa Valley, near Blaine, Cherokee county, Alabama. H. N. Stokes, analyst. Bulletin No. 168, U. S. Geol. Survey, 1900, p. 283.

II. Oostanaula (Conasauga) shales, about two miles northwest of Cartersville, Bartow county, Georgia. J. M. McCandless, analyst. Paleozoic Group, Geol. Survey of Georgia, 1893, p. 285.

Chemical analyses of the partially weathered Conasauga shales near Cartersville are here given.

	I Per Cent.	II Per Cent.
Silica, SiO_2 (free sand)	62.30	39.20
Silica, SiO_2 (combined)	9.30	19 40
Alumina, Al_2O_3	11.50	18.05
Iron Sesqui-oxide, Fe_2O_3	5.59	8.31
Manganese Di oxide, MnO_2	0.60	——
Lime, CaO	none	none
Magnesia, MgO	1.30	1.55
Potash, K_2O	4.20	4.63
Soda, Na_2O	0.35	0.33
Titanic Oxide, TiO_2	1.10	0.68
Water, H_2O (combined)	3.80	7.60
Water, H_2O (hygroscopic)	0.16	0.40
Total	100.19	100.15

I. Light-colored hydromica shale on the ridge above the Etowah iron bridge south of Cartersville. On the border of the metamorphic zone. Paleozoic Group, Geol. Survey of Georgia, 1893, p. 284. J. W. Spencer. (McCandless, analyst).

II. Light-red shale in the valley, one mile southwest of Cartersville. Paleozoic Group, Geol. Survey of Georgia, 1893, p. 284. J. W. Spencer. (McCandless, analyst).

THE KNOX DOLOMITE

The Knox dolomite lies next above the Conasauga shales. The lower beds are probably Cambrian; but, owing to the paucity of fossils in it and the striking uniformity in lithologic character, the entire formation is here classed as Silurian. Hayes says: "From the few fossils which have been found it appears probable that a transition from the Cambrian to Silurian occurs in the lower third of the formation, but it is generally impossible to determine this line of division."[1] It is the most uniform and persistent one of the southern Appalachian terranes. It is a massively bedded, partially crystalline, gray magnesian limestone containing abundant nodules and layers of chert or flint.

On weathering of the dolomite, the removal, by solution, of the soluble calcium and magnesium carbonates leaves the limestone surface prevailingly covered with a heavy mantle of insoluble siliceous clay abundantly admixed with chert fragments and masses. The

[1] Geologic Atlas of the United States. Rome Folio, U. S. Geol. Survey, 1902, p. 3.

residual clay is usually of light color, containing only a limited quantity of iron oxide. The proportion of clay to chert varies; but the percentage of chert is always large. It is by means of its residual material, especially the chert nodules and masses, that the Knox dolomite can be traced, for it is seldom exposed except along some of the streams.

The Knox dolomite has an estimated thickness of 3,000 to 5,000 feet. As a producer of manganese ores, the Knox dolomite is perhaps of less importance in the immediate Cartersville district, than either the Beaver limestone or the Weisner quartzite. It is, however, of great importance as an ore-producer over many parts of the Paleozoic area beyond the limits of the Cartersville district. In these adjacent regions, it is intimately associated with extensive deposits of iron ore, bauxite and manganese.

Numerous chemical analyses have been made of the Knox dolomite from samples of the rock collected from many localities in Georgia. The analyses available show its composition to vary within the following limits: —

Silica, SiO_2	3.75	to	7.25	Per	cent.
Alumina, Al_2O_3 and Iron Sesqui-oxide, Fe_2O_3	1.24	to	1.76	"	"
Lime, $CaCO_3$	34.07	to	53.44	"	"
Magnesia, $MgCO_3$	36.32	to	55.74	"	"

THE OLDER CRYSTALLINE AND METAMORPHIC ROCKS OF THE CARTERSVILLE DISTRICT ON THE EAST SIDE OF THE CARTERSVILLE FAULT

In this area, several types of crystalline metamorphic rocks are represented, which show considerable variety in composition and age. Of these, the Corbin granite area, which occupies the middle eastern portion of the map, is the most extensive. As mapped, this granite mass is a roughly oval-shaped area extending from Stamp Creek P. O. on the north side, to the line of the Western & Atlantic railroad on the south, and continuing eastward into Cherokee county. The granite is a coarse-grained porphyritic rock presenting a distinct augen-gneiss facies in the border portion. It is composed of large microcline phenocrysts, embedded in a ground-mass of blue quartz, plagioclase, augite and mica.

Its chemical composition is shown in the following analysis made in the laboratory of the U. S. Geological Survey by Dr. H. N. Stokes,[1] of specimens collected by Mr. A. H. Brooks, of the same Survey, one mile east of Rowland, Bartow county, Georgia: —

	Per cent.
Silica, SiO_2	67.98
Alumina, Al_2O_3	14.84
Iron Sesqui-oxide, Fe_2O_3	1.00
Iron Protoxide, FeO	3.15
Magnesia, MgO	0.91
Lime, CaO	2.17
Soda, Na_2O	2.66
Potash, K_2O	4.76
Water, H_2O at 110°	0.14
Water, H_2O above 110°	0.49
Titanic Oxide, TiO_2	0.84
Phosphorus Pentoxide, P_2O_5	0.34
Manganous Oxide, MnO	trace
Baryta, BaO	0.20
Strontia, SrO	trace
Lithia, Li_2O	trace
Sulphur, S	0.08
Chlorine, Cl	trace
Fluorine, F	trace
Carbon, C (Graphite)	0.21
Total	99.77

Mr. Brooks has given the following petrographic data on the granite from this locality: "Contains microcline, some plagioclase, abundant pyroxene partly altered into chiefly uralite and chlorite, some biotite with frequent inclusions of rutile, much blue vitreous quartz, apatite, zircon and magnetite." [2]

In places, the border portion of the granite area, is surrounded by a coarse feldspathic conglomerate, the mineral constituents of which were clearly derived from the granite mass, since the microcline and blue quartz of the granite enter largely into the composition of the conglomerate. In other places, the border portion of the granite is in contact with a series of black graphitic slates. As yet,

[1] Bulletin No. 168, U. S. Geol. Survey, 1900, p. 55.

[2] Bulletin No. 168, U. S. Geol. Survey, 1900, p. 55.

fossils are unknown in the conglomerates and slates; and, on account of their appearance of extreme age, Hayes has grouped them as Algonkian (Ocoee).[1] The Ocoee series has its greatest development in eastern Tennessee and western North Carolina.

To the south of the Corbin granite area, the conglomerates and slates increase in metamorphism, and apparently pass into gneisses and schists, whose origin, whether igneous or sedimentary, is unknown.

The extreme southeastern corner of the mapped area,[2] comprises narrow belts of granite and gneiss, and amphibolite schist. According to Hayes,[1] both diabase and diorite are represented in the area. Diorite is thought to be the most common type of rock, now altered, for the most part, into the amphibolite schist of the area.

Structure

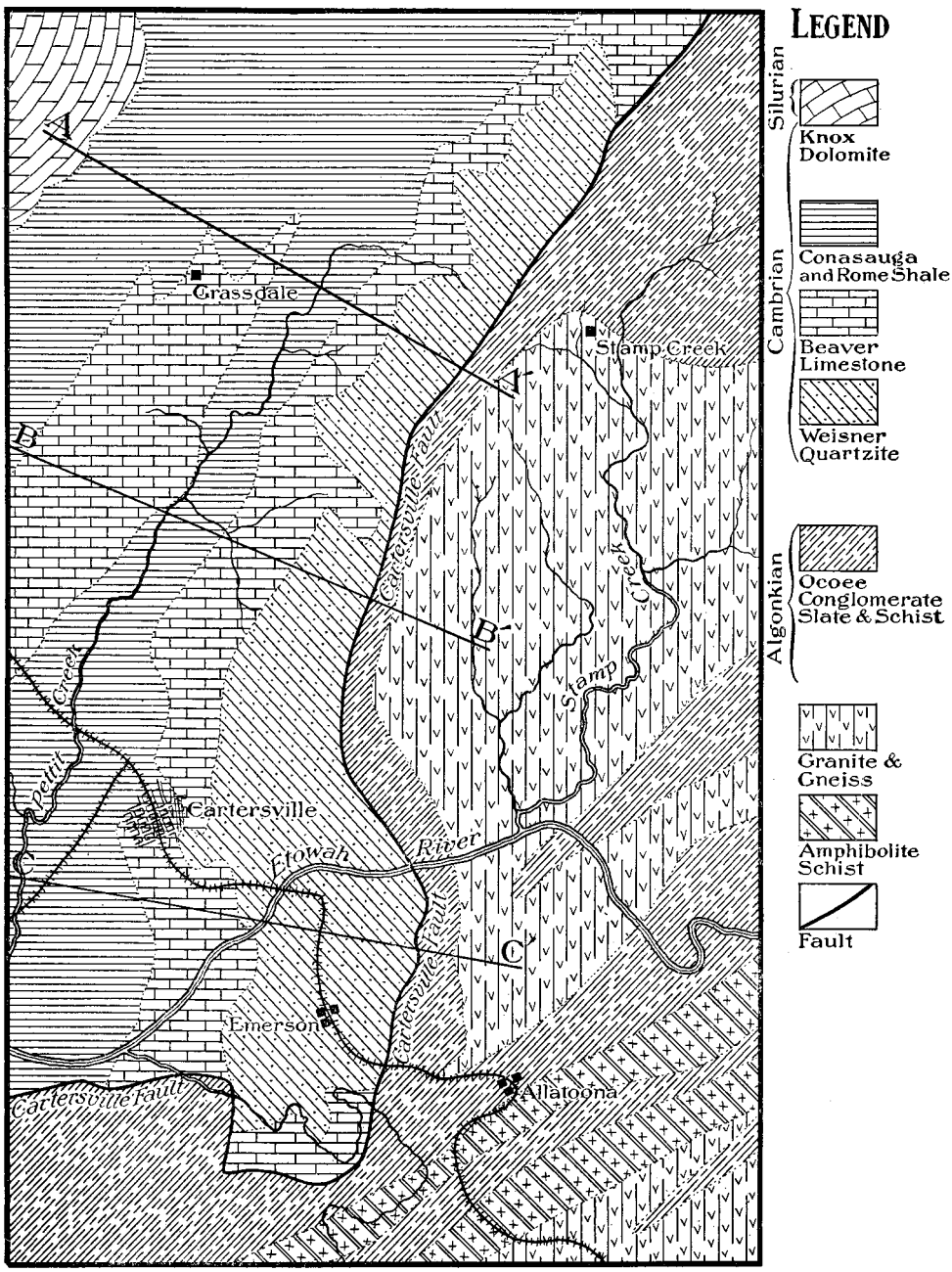
The structural features of the Cartersville district are of economic as well as of scientific importance; since some of the ore-deposits, at least, are intimately associated with certain structural lines. The three sections, reproduced below, and indicated on the map,[2] by the lines A A′, B B′ and C C′, give an excellent idea of the structural relations of the rocks included within the limits of the mapped area. The area has been one of prolonged and intense compression exerted in a northwest-southeast direction. As a result of this intense metamorphic action, the rocks are profoundly altered, and those which were originally entirely unlike have been so changed, that frequently the products are scarcely, if at all, distinguishable at present.

The rocks on the east side of the fault line have been mashed and squeezed, and the slaty and schistose structures are strongly developed; while the rocks on the west side of the fault have been complexly folded and fractured. The Knox dolomite and the Weisner quartzite resisted folding to a greater degree than the Conasauga formation, on account of their more massive character. Field study indicates, that the Knox dolomite was more resistant than the Weisner quartzite. The beds of the latter are thrown into numerous irregular folds; and, from its crushed and brecciated condition in

[1] Geological Relations of the Iron Ores in the Cartersville District, Georgia: Trans. Amer. Inst. M. E., 1901, Vol. 30, p. 408.

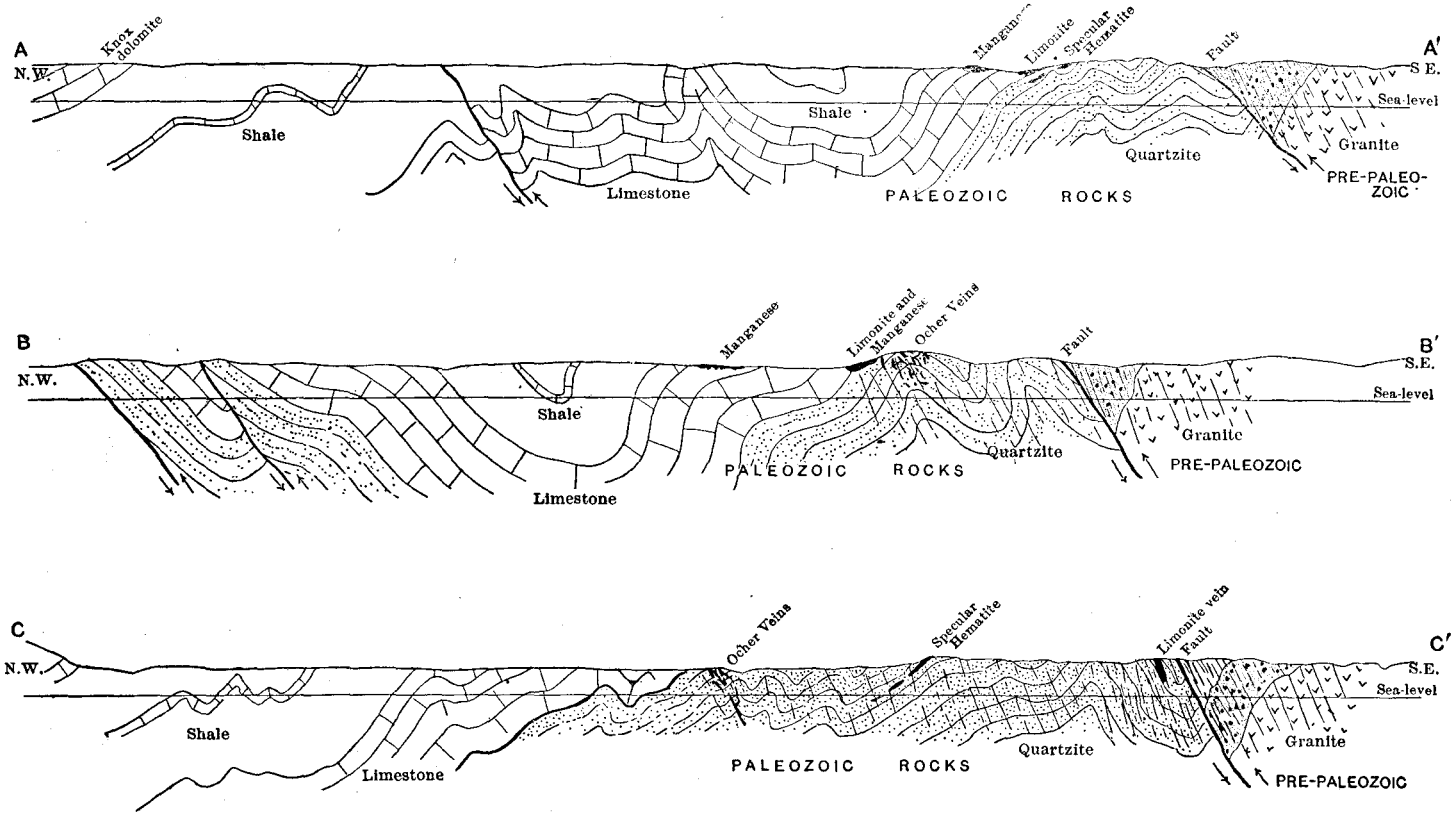
[2] See Fig. 1 p. 44.

Fig. 1



Geological Map of the Cartersville District, Bartow County, Georgia. (After C. W. Hayes.

Fig. 2



Sections on Lines Indicated in Fig. 1, Showing Geological Structure of the Cartersville District. (After C. W. Hayes)
Scale, Horizontal and Vertical, 1 Inch=5,000 Feet.

many places, it was presumably faulted; although the character of the outcrops probably do not admit of the location and tracing of the faults in the field.

The conditions along this faulted and crushed zone must have been at the time especially favorable to increased chemical action. In places, the quartzite is rendered spongy and porous in texture, and the cavities are filled with hydrous yellow oxide of iron, ocher; and, in some cases, a lining of small quartz crystals, indicating the solvent and precipitating powers of the circulating waters.

On the east side of the fault, the granite area, while considerably squeezed and foliated in places, resisted the dynamic forces to a greater degree than did the associated sedimentaries of the Crystalline Area, as is indicated in the well developed slaty cleavage and schistose structure.

The Cartersville fault enters northwest Georgia to the east of Cohutta Springs in Murray county; and its position is marked by an irregular north-south line, to within a few miles east of Cartersville, where it passes around the limestone and quartzite of the Lower Cambrian, as a distinct southwest embayment from Cartersville; thence it trends in a generally westward line into Alabama. In the Cartersville district, the line of contact is marked by the slates of the Ocoee series on the east side, with the Cambrian shales on the west side. The plane of contact has thus been observed at several places. Where observed, the fault plane is marked by a breccia zone several feet across, composed of fragments derived from the formations on the two sides. The older crystalline metamorphic rocks on the east, forming the upthrow side, indicate scarcely more alteration immediately at the contact than away from it; while the Paleozoic sediments of the downthrow side invariably show more intense folding and brecciation at the fault, than at some distance away from it. The fault plane has a low eastward dip, varying from 5° to 20°, conforming in a general way to the bedding planes of the rocks. This fault is one of the principal major thrust-faults of the southern Appalachians; and it is the largest one in northwest Georgia.

THE MANGANESE ORE DEPOSITS OF THE CARTERSVILLE DISTRICT

MODE OF OCCURRENCE OF THE MANGANESE ORES

The Manganese ores occur embedded in the heavy mantle of residual clays derived from the decay of the Beaver limestone and Weisner quartzite (Chilhowee sandstone of Safford); and the ores have nearly equal distribution in the decay derived from the two formations. The residual decay derived from the two formations is, in the case of the Weisner quartzite, composed of light-gray to yellow colored siliceous clay, more or less admixed with angular fragments of the partially decayed quartzite. That of the Beaver limestone consists of a deep-red clay admixed with some chert fragments; and, along and near its eastern contact with the quartzite ridges, additional fragments of the latter rock. Chocolate-brown and black clays (umber), stained with the manganese oxide, are common to the area. The quartzite fragments are frequently in an advanced stage of disintegration, sometimes forming a mass of incoherent white quartz grains easily dug out with the finger. At other times, the quartz fragments readily crumble into sand under the gentlest pressure of the hand. Still, others, mingled with the clay, have only been slightly discolored, and are otherwise apparently as hard and firm as the fresh quartzite. The harder fragments are often cemented by manganese oxide, which forms a distinct manganiferous quartzite breccia.

The ore is distributed through the clay in irregular small pockets, rarely in distinct beds; in the form of veins and stringers penetrating the clay in an irregular manner; and as concretions or nodules of various sizes and shapes, from masses weighing several tons to small disseminated grains scattered through the clay. At times, the ore distribution in the clays conforms, in a general way, to the bedding of the enclosing material; more often, however, this is obscured and the ore-bodies are seen penetrating and cutting the clay indiscriminately. The character of the ore distribution through the clay has, as will be seen later, an important bearing on the occurrence of the ore in the original fresh rock.

The ore-bearing pockets vary much in number and size, being comparatively close together in some places, and some distance apart

in others, as much as a hundred feet and more in extreme cases. The pockets vary in size from mere nests to bodies six or more feet thick, and more than thirty feet long. They may, in extreme cases, yield hundreds of tons of the ore, more frequently, however, much less; and they are composed of both the massive and the nodular partially crystalline ore. They are sometimes composed of solid ore, though usually they are composed of numerous nodules somewhat closely assembled in the enclosing clay. The pockets and lenticular masses, resembling at times true beds, are usually disconnected; but they are frequently connected by small stringers and veins of the ore. In this mode of occurrence, the ore is necessarily mixed with more or less clay and siliceous fragments, and invariably some included silica, from all of which the ore is freed and cleansed by screening, washing and jigging, a process described in some detail in a subsequent part of this report.

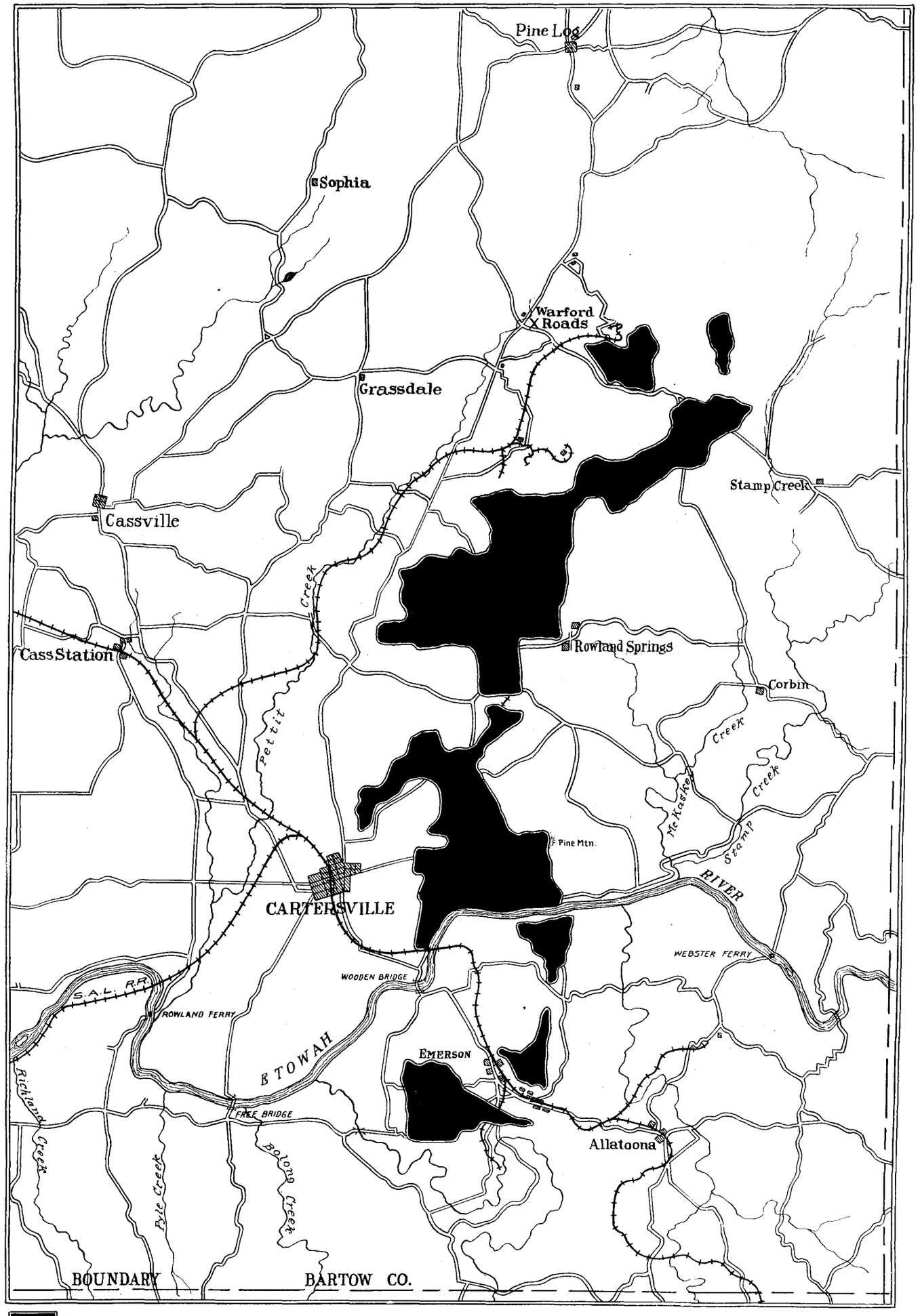
The proportion of clay to ore is usually larger than in the closely associated brown iron-ore deposits of the district. Somewhat extensive accumulations of a finely divided black manganese powder, probably a mixture of the various oxides of manganese, are scattered through the clays. These are occasionally of sufficient purity to be carefully taken out and shipped without attempting to cleanse it. More often the ore is partially or completely crystalline and of a dark-blue color. The manganese ore of the Cartersville district is prevailingly more crystalline, than that of any other section of the Paleozoic area of Georgia.

The workings are usually confined to the tops and slopes of the quartzite and limestone ridges; less often are they to be found in the valley bottoms. Surface indications may occur in the form of concretions or nodules, and as broken fragments and small grains and granules of the ore strewn or scattered over the surface; or, as a clay coloring, forming a chocolate tinted clay, due probably to the finely disseminated earthy particles of the ore through the clay, known as umber.

DEPTH OF THE RESIDUAL DECAY

The clay, in which the manganese ores occur, represents the weathered product of the surface decay of the original rock *in situ*.

Fig. 3



Manganese

Map of the Cartersville District, Georgia, Showing the Distribution of the Manganese Deposits, by Thomas L. Watson, Based on the Cartersville Topographic Sheet, U. S. Geological Survey.

The depth of the rock decay varies greatly. It is dependent, other things being equal, on the character of the rock and on the attitude of the rock-strata. In the Cartersville district, the quartzite has been much broken and crushed, and is thrown into a series of narrow, more or less steep folds or ridges. The top and slopes of the ridges, as well as the valley bottoms, are covered to some depth with the quartzite decay. It is not uncommon, however, to find reefs of the hard fresh rock occupying areas along the ridge crests in the residual decay.

In several places, shafts have penetrated to a depth of several hundred feet without piercing the bed-rock. Depths of one hundred feet and more are common in the district. It follows from this, that the depth of the residual decay is considerable, and represents a continued exposure of the rocks to the attack of the atmospheric agencies through a long time interval.

KINDS OF ORE

Only the oxides of manganese occur in the Cartersville district. Of these, pyrolusite and psilomelane greatly predominate, with some manganite and braunite, and much of the earthy oxide, wad. These can not always be separated; but they usually occur admixed in varying proportions. With the exception of the wad, the ore is usually either partially or wholly crystalline, with druses of minute crystals of pyrolusite abundant through the masses, and is of dark steel-blue color; and the nodular type nearly always displays the complete or partial layered or concentric structure, characteristic of concretionary masses.

ASSOCIATED ORE DEPOSITS

Extensive deposits of brown iron-ore, gray or specular hematites, yellow ocher, and, to a less extent, barite (heavy spar) and bauxite occur intimately associated with the manganese deposits in the Cartersville district. Of these, the deposits of iron-ore and yellow ocher have been extensively worked, and the district is one of the principal producers of these ores in the State. Yellow ocher is mined only in the Cartersville district, limiting the entire production

in the State to this area. The deposits of bauxite and barite are of minor importance, only; since the former is but sparingly found near the limits of the district, and the latter, while more abundant, is not sufficiently concentrated to admit of profitable working.

The relations of the manganese to the bauxite deposits are less close than in many other areas in the State. Barite, as before stated, is quite generally distributed over the area mapped; but it is not sufficiently concentrated to be profitably worked. Several land-lots, originally extensively worked for manganese, yielding hundreds of tons of the ore in each case, are, at present, being equally as profitably worked for yellow ocher. The shafts, cuts and tunnels opened for the manganese are now used in part in mining the ocher, a fact which further emphasizes the very close and intimate association of the two ore-deposits.

MANGANIFEROUS IRON ORES

The beds of limonite, which is the prevailing type of iron ore in the district, are usually distinct from, though occurring in close relation (side by side) with the manganese ores. At times, the oxides of iron and manganese are found admixed in different proportions in the same bed. Between the two extremes of pure iron ore and pure manganese ore, occur all gradations in the admixture of the two oxides. In some beds of average thickness, the two materials are homogeneously admixed, giving the appearance of a manganese ore when the iron is present in small quantities, and of the usual limonite ore when manganese is in small quantities. In other cases, beds of iron ore are found encrusted at the surface, for only a slight depth, with the pure oxide of manganese, which, on being opened, proves to be a good deposit of iron and not of manganese ore. Still, a few other deposits have been observed in this district, which presented an interlamination of the two materials, layers of the iron ore alternating with layers of the manganese ore.

Analyses of the iron ores invariably show small percentages of manganese; and, conversely, the manganese ores show varying percentages of iron, with intermediate gradations, in which the two oxides are nearly equal in amount, forming a good grade of manga-

niferous iron ore. These gradations are brought out in the following analyses of samples of the ores from the district: —

	Lot No. 174[1] Per Cent.	*Lot No. 171*[1] Per Cent.	*Lot No. 260*[1] Per Cent.	*Lot No. 460*[1] Per Cent.
Manganese	41.980	36.00	25.090	15.260
Iron	16.220	16.88	29.170	39.250
Phosphorus	0.227	0.14	0.155	0.193

	Lots 613 & 614[1] Per Cent.	*303 & 274*[1] Per Cent.	*Lot No. 391*[1] Per Cent.	*Lot No. 306*[1] Per Cent.
Manganese	47.19	54.940	46.510	35.320
Iron	10.22	3.620	3.300	3.110
Phosphorus	0.28	0.034	0.055	0.063

	Kinsey Bank[2] Per Cent.	*Lots 303 & 274*[1] Per Cent.	*Barlow Property*[2] Per Cent.	*Pine Hill* Per Cent.	*Lot No. 465*[2] Per Cent.
Iron	51.170	56.680	52.02	52.190	54.570
Manganese	2.254	1.870	2.30	1.520	.382
Phosphorus	1.045	0.864	0.24	1.036	.722

	Lot No. 575[2] Per Cent.	*Lot No. 465*[2] Per Cent.	*Lot No. 312* Per Cent.	*Laramore* Per Cent.
Iron	51.850	54.570	1.450	1.290
Manganese	0.125	0.382	60.610	56.400
Phosphorus	0.168	0.722	0.052	0.158

CHEMICAL COMPOSITION

The few analyses of the Cartersville manganese ores, quoted below, are from carload shipments, which furnish the safest criterion of a just estimate of the commercial value of the ore; since single hand samples of a deposit may not be representative of the deposit.

[1] Private report of S. Albert Reed, of New York City, to the Etowah Company. Published, 1892.

[2] Geol. Survey of Georgia, Bul. No. 10, The Iron Ores of Georgia: Polk, Floyd and Bartow Counties, by S. W. McCallie; 1900, p. 112 *et seq.*

Analyses of Carload Shipments of Manganese Ore from the Cartersville District[1]

Manganese	Iron	Silica	Phosphorus	Moisture
41.248	9.100	14.400	0.109	2.000
41.630	1.990	10.820	0.050	4.000
42.856	10 491	7.300	0.139	6.000
44.308	4.595	10.950	0.156	6.000
39.893	10.210	12.720	0.106	6.000
47.080	5.600	low	0.194	——
46.400	——	5.250	0.277	——
48.350	——	2.600	0.122	——
39.690	5.850	11.860	0.210	——
41.410	——	4.500	0.134	——
40.310	——	3.760	0.127	——
49.320	——	3.780	0.208	——
47.250	——	5.610	0.198	——
43.710	——	7.100	0.236	——

These analyses, which represent the average composition of the Cartersville manganese ore in bulk, are sufficient to indicate chemically the commercial value of the ores. They do not differ essentially from analyses of similar high grade ores occurring elsewhere. It will be observed, that the manganese average is uniformly high, with correspondingly low iron, silica and phosphorus.

As a rule, very few of the better grades of the Cartersville ores are injured by a high percentage of silica. This ingredient will generally average low, in those cases where the ore has been properly cleansed. It rarely ranges above ten per cent., and is usually much below this, averaging from two to five per cent. In many of the lower grade ores, the silica averages considerably more than ten per cent. In many analyses of the Georgia ores, the apparently high silica percentage might easily be lowered considerably, by properly washing and cleansing the ore from adhering clayey matter before shipping. High silica is particularly noticeable in many analyses of the ores mined in the early period of the district's development. This was largely, if not entirely, due to the operators shipping the ore direct from the mines, with little or no previous cleansing.

[1] Furnace returns, furnished the Survey through the courtesy of the mine owners in the Georgia area.

The phosphorus content in the Cartersville deposits is rarely high enough to be of any detriment to the value of the ore. The manganese ores are prevailingly characterized by a low phosphorus percentage. The average in this ingredient for the better grade ores of the district is from 0.10 to 0.15 per cent. Rarely does it rise above 0.20 per cent.

GENESIS OF THE ORES

The mode of occurrence of the manganese ores described above unquestionably place them as secondary deposits. The manganese oxides were derived from the Beaver limestone and Weisner quartzite by decay, and were subsequently concentrated in the residual clays of these two formations by chemical and physical processes. It is possible, as held by Penrose,[1] that some of the deposits existed in their present concentrated form in the rocks of the area before weathering, and are in such cases entirely residual deposits. Sufficient evidence is lacking, from the writer's study of the area, to confirm this view. The origin of the manganese deposits in Georgia is discussed in detail elsewhere in this report, to which the reader is referred for a full statement of fact.

[1] Manganese: Its Uses, Ores, and Deposits; Geol. Survey of Arkansas, Ann. Report for 1890, Vol. I, p. 418 *et seq.*

CHAPTER III

MANGANESE DEPOSITS OF THE PALEOZOIC AREA
(Continued.)

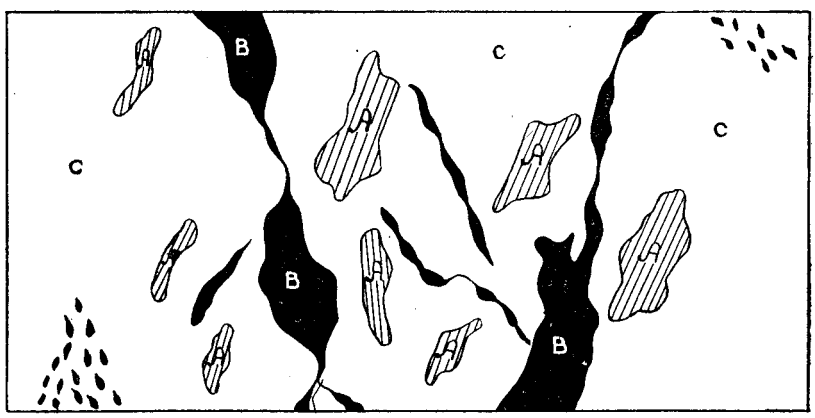
DESCRIPTION OF INDIVIDUAL PROPERTIES IN THE CARTERSVILLE DISTRICT

THE BLUE RIDGE MINING COMPANY'S PROPERTY

This property was formerly owned by the "Etowah Iron Company," by which name it was known for many years. In August, 1900, the Etowah Company sold the property to a northern syndicate, when the name was changed to the "Blue Ridge Mining Company." The general offices of the company are located in New York City, and the local office is at Cartersville, Georgia.

The property includes 17,500 acres of mineral lands situated in

FIG. 4



Section in one of the openings on the Blue Ridge Mining Company's property, near Cartersville, Georgia, Showing the Mode of Occurrence of the Manganese Ore in the Residual Clay. A. Partially Decayed Rock Fragments and Masses. B. Manganese Ore. C. Residual Clay. *Horizontal and Vertical Scale: 1 inch=17 feet.*

Bartow and Cherokee counties, 14,000 acres of which are in Bartow county and the remaining 3,500 acres, in Cherokee county. It is located directly on the Western and Atlantic railroad, to the north and east of the town of Cartersville, 90 miles south of Chattanooga and about 40 miles northwest of Atlanta. The Etowah river, one of the largest streams in northwest Georgia, flows through the property, giving a river frontage of four miles on the two sides. The estimated fall in the river for the four miles is 70 feet, which is computed to develop 12,600 horse power at the lowest stage of water. Sixteen miles of railroad have been in operation on the property, connecting with the main line of the Western and Atlantic railroad. Ten of the sixteen miles of the road are of broad-gauge track, and the remaining six miles are of 36-inch gauge, with full rolling stock for the six miles.

The property is well set in second growth pine, interspersed with some hardwood, insuring abundant fuel in the form of charcoal, and is well suited for timbering mines and other purposes of construction. It further contains large areas of limestone of excellent fluxing qualities, which were abundantly tested before the Civil War in the furnaces of the Mark A. Cooper Iron Works, located on the Etowah river, a few miles east of Cartersville. An average analysis of the limestone on this property gave Mr. S. Albert Reed of New York City the following results: —

Calcium Carbonate, $CaCO_3$	75.18
Magnesium Carbonate, $MgCO_3$	20.00
Iron Sesqui-oxide, Fe_2O_3 / Alumina, Al_2O_3	2.60
Insoluble Matter	1.08
Undetermined (Moisture and Loss)	1.14
Total	100.00

This property has been extensively worked, from time to time since the early forties, for iron ore. It was worked continuously from the early forties until the year 1864, and again, at intervals from 1864 to 1892. After the Etowah Company obtained possession in 1888, it was worked for both iron and manganese. The deposits of iron ore, consisting of limonite and gray specular hematite, are of the best quality, and among the largest in the district.

The following lots of land owned by the Blue Ridge Mining Company have been prospected and worked for manganese: —

Lot	Area in Acres	District	Section	County	Remarks
613	40	4	3	Bartow	Old workings.
614	"	"	"	"	Worked at present.
542	"	"	"	"	Old workings.
473	"	"	"	"	New openings.
464	"	"	"	"	Being worked.
465	"	"	"	"	" "
400	"	"	"	"	" "
401	"	"	"	"	Recently worked.
393	"	"	"	"	Old workings.
392	"	"	"	"	" "
391	"	"	"	"	" "
460	"	"	"	"	Being worked.
260	"	"	"	"	Old workings.
113	"	"	"	"	" "
114	"	"	"	"	Recently worked.
360	160	5	"	"	Being worked.
305	"	"	"	"	" "
303	"	"	"	"	Old workings.
274	"	"	"	"	" "
306	"	"	"	"	

Lot 613. — This lot was worked some years ago, and a large amount of manganese was reported to have been shipped. One tunnel and a single shaft include the openings from which the ore was mined. Recently, work was resumed on the edge of the old openings; it comprises an open-cut and one shaft, 30 to 40 feet in depth. Four car-loads of the ore have been shipped from the recent openings.

The ore is distributed through a light-yellow siliceous residual clay, derived from the decay of the Weisner quartzite. It consists chiefly of the concretionary nodular type. It is dark steel-blue in color, and, for the most part, is non-crystalline. Surface indications for manganese are good, over the entire lot. Considerable work of an indifferent kind has been done. In some of the recent openings

the show of ore is very good. The older workings had fallen in to such an extent, that a satisfactory examination was impossible. A good grade of brown iron ore occurs on this lot, in close association with the deposit of manganese.

LOT 614. — Surface indications for manganese are very good in places on this lot; but the work done has been very limited. So far as work has extended, the occurrence and the character of the ore are quite similar to that on the adjoining lot, *No. 613*.

LOTS 613 AND 614 occupy a part of the southeast slope of an approximately north-south trending ridge of Weisner quartzite. The openings are near the top of the ridge.

The following is an analysis of the ore from *lot 614*, by Mr. S. Albert Reed, of New York City: —

	Per Cent.
Manganese	47.19
Iron	10.22
Phosphorus	0.28

LOT 542. — No work has been done on this lot for some years; and the openings were largely filled-in from caving, at the time of my examination. No record of the quantity of ore removed is available; but, judging from the limited excavations, only a small quantity of the ore was mined. The dump-piles indicate the same grade and character of ore, as that mined on the two lots described above. The lot is situated on the west slope and near the top of a quartzite ridge. Favorable ore indications appear over the entire surface. Several good exposures of limonite occur near the manganese, samples of which yielded Mr. S. Albert Reed, of New York City, the following results on analysis: —

	Per Cent.
Iron	56.680
Manganese	1.870
Phosphorus	0.864

LOT 473. — No systematic mining has been undertaken on this lot, though considerable work has been done over most of its surface; and a large quantity of the manganese ore has been removed. The ore was mined mostly from small pits and prospect openings, in

addition to several large cuts and tunnels, which are now nearly filled from caving. The greater part of the work is of long standing, though four cars of the ore have recently been mined.

The ore consists of fine gravel and large concretionary nodular masses, embedded in yellow siliceous clay, derived from the decay of the quartzite. The following analysis of samples of the ore from this lot, kindly furnished the Survey by Capt. John J. Calhoun, of Cartersville, Ga., will indicate its general character: —

	Per Cent.	Per Cent.
Manganese	37.750	35.190
Silica	6.050	8.950
Phosphorus	0.222	0.206

The manganese is closely associated with large deposits of yellow ocher, of good quality. The elaborate manganese mill, built by the Etowah Company and equipped with modern expensive machinery, is on this lot, only a few rods from the Etowah river.[1]

Lot 464. — A large number of excavations, in the nature of open-cuts, tunnels and prospect pits over this lot indicate extensive working and that a large quantity of the ore was removed. The residual clay is largely admixed, in places, with large and small fragments of the quartzite, derived from the decay of the Weisner formation. The angular quartzite fragments are cemented in a black manganiferous matrix, as manganiferous-quartzite breccia. Much of the ore is in the breccia form; and usually it is of no value; since the quantity of ore is so small, that separation from the quartzite fragments is rendered practically impossible.

Two carloads of the ore were shipped from the prospect pits alone. The following partial analysis of the ore from this lot was kindly furnished the Survey by Capt. John J. Calhoun, of Cartersville, Ga.: —

	Per Cent.
Manganese	37.750
Silica	6.050
Phosphorus	0.222

The manganese ores are intimately associated with large de-

[1] See plate IV.

posits of an excellent grade of yellow ocher; and, in the northwest corner of the lot, some barytes is found with both the manganese and ocher. The ocher has not been worked; but indications point to a rather extensive body; since it is exposed in nearly all the numerous openings made.

Lot 465. — The first mining on this lot was in January, 1900. It was continued through the spring and summer of the same year. The lot occupies the middle slope of a gently sloping but high quartzite ridge facing the Etowah river. The workings consist of one open-cut, from which a tunnel was driven directly into the slope of the ridge, and the ore, worked on several levels. Adit levels were run from the two sides of the tunnel, and much ore was removed. The ore occurs in the form of pockets and stringers enclosed in the highly siliceous yellow clay commingled with abundant quartzite fragments. The fragments of quartzite are in various stages of decay. Some are hard and firm with only slight discoloration; but much of it readily crumbles into sand, when pressed in the fingers. Fine gravel and crystalline, massive lump and needle ore compose the bulk of the ore-body. Stalactitic and mammillary structures are beautifully developed in much of the massive lump ore. Many lumps of practically pure crystallized ore were removed, which averaged more than 100 pounds each in weight. Twelve hundred tons of high-grade ore were shipped prior to September, 1900.

The prevailing color of the residual clay is yellow; though much dark-chocolate colored clay was exposed. Numerous prospect-openings, of small size and shallow depth, were made over many parts of the lot some years ago, without the detection of favorable indications for manganese. The following commercial analyses of carload lots of this ore, kindly furnished the Survey by Capt. John J. Calhoun, of Cartersville, show the high-grade character of the ore: —

	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Manganese	47.080	43.710	46.400	44.590	48.350	39.950	47.250
Iron	5.600	———	———	———	———	———	———
Silica	———	7.100	5.250	6.820	2.600	12.920	5.600
Phosphorus	0.194	0.236	0.277	0.144	0.122	0.198	0.198

Lot 400. — Two openings, of small dimensions, have been made

on this lot. A recent shaft, opened on the summit of the high quartzite ridge, from 15 to 20 feet deep, showed, for the entire depth, abundant nodules of crystallized ore thickly studded in the clay. One carload of the ore was taken from this opening, and was ready for shipment at the time of my visit. The results on analysis of samples of the ore from this shaft are: —

	Per Cent.
Manganese	47.250
Silica	5.610
Phosphorus	0.198

A second recent opening was made near some old ones in the southwest corner of the lot, from which less than one carload of the ore was removed. Two carloads of the ore were reported to have been shipped from an old shaft near by. The ore in the shaft on top of the ridge is, in all respects, similar to that mined in the southwest corner of the lot. An analysis of the ore from the opening in the southwest corner of the lot gave: —

	Per Cent.
Manganese	39.020
Silica	13.500
Phosphorus	0.245

The high silica in this analysis is due to the ore not having been freed from the adhering clay.

This lot (No. 400) is located on the summit of a high quartzite ridge, which overlooks, or bounds in part, Hurricane Hollow, including *lots 394, 399, 466 and 467*, which comprise some of the most important and extensively worked brown iron ore deposits in the Cartersville district. These deposits have been described by Mr. S. W. McCallie in a previous report of the Survey.[1]

Lot 401. — Several openings, one a small tunnel, and the others open-cuts, of fair size, have been worked along the railroad spur, and one carload of the ore has been shipped. The ore is all fine gravel, of good quality; and, from indications along the faces of the openings, it exists in considerable quantity.

[1] A Preliminary Report on a Part of the Iron Ores of Georgia: Polk, Bartow and Floyd counties, 1900, Geological Survey of Georgia, Bulletin No. 10—A, pp. 136–139.

LOTS 391, 392 AND 393. — These lots of land occupy the south slope of a quartzite ridge in the region near Pine mountain. Considerable work was done, in places, over these lots some years ago. It was all in the nature of open work; and, on account of long standing the openings had filled to such an extent by caving, that little or nothing was visible, at the time of my examination. Those parts of the sides of the cuts, still exposed to view, show, in every case, good faces of manganese ore. Additional ore is seen scattered in small loose fragments over the surface and the dumps.

Mining has been more extensive on *lot 391*, than on the other two. The excavations are larger than usual, and the grade of wash-ore was said to have been very good. Samples of the ore collected by Mr. S. A. Reed, of New York City, gave, on chemical analysis: —

	Per Cent.
Manganese	46.510
Iron	3.300
Phosphorus	0.055

An analysis of samples of ore from the same lot yielded Professor H. C. White, of the State University at Athens, Ga., the following results: —

	Per Cent.
Manganese Dioxide, MnO_2	87.600
Iron Sesqui-oxide, Fe_2O_3 / Alumina, Al_2O_3	9.135
Silica, SiO_2	2.175
Sulphur, S	0.010
Phosphorus, P	0.065
Water, H_2O, and Organic Matter	1.015
	100.000

Equivalent in metallic manganese 54.75

Extensive deposits of brown iron ore, which were largely worked before the Civil War by the Mark A. Cooper Iron Company, occur on the three lots, intimately associated with the manganese ores. On *lot 392*, is a large exposure of manganiferous iron ore, not yet worked.

LOTS 113 AND 114. — Some work was done last year, under lease, on *lot 114*, when one carload of the ore was shipped. The opening is near the public road, within a few feet of an excellent deposit of yellow ocher. The heavy-bedded quartzite is exposed at this point along the road, in an outcrop ten or more feet high, with the beds dipping nearly vertical. The quartzite is considerably crushed and fractured, and is highly impregnated, in places, with both manganese oxide and yellow ocher. Particles of these ores are well shown on a freshly broken surface of the quartzite. Indications of manganese appear on both sides of the quartzite exposure, in the clay, where small test-pits have been opened. The principal work consists of a single small open-cut, with one shaft, less than twelve feet deep, sunk from the bottom of the cut.

The adjoining lot *113*, on the opposite side of the Rowland Springs road, indicates that a fair amount of work was done some years ago. It is said, that Mr. A. P. Silva, who did the mining on this lot, removed a large quantity of ore, of excellent quality. No ore was in sight in the old excavations; since they were nearly entirely filled from caving. The grading along one of the Company's railroads has exposed some ore in the shallow cuts. The ore-bearing clay in the railroad cuts is admixed in large proportions with fragments of the quartzite.

LOT 460. — This lot has produced a large quantity of high-grade ore. Five large tunnels, run directly into the quartzite ridge, near its base and on the gently north-sloping side, comprise the principal work. The tunnels cut through the entire mantle of residual decay into the hard and fresh quartzite. Red, yellow and dark-chocolate colored clays were cut by the tunnels. The older work, which was done many years ago, was poorly timbered, and had fallen in, to such a degree, as to make examination in them unsafe. The tunnel nearest the top of the ridge has recently been worked; and it penetrates, for most of its distance, the lighter colored, yellow clay. The clay is much faulted and slicken-sided, in places, in the tunnel, and readily gives way. A three-foot face of excellent gravel ore is exposed at the end of the topmost tunnel, in the yellow clay near the bottom. The dumps indicate a preponderance of the gravel type of ore, admixed with some nodular and lump ore, from two to eight

inches in diameter. Much of the finely divided or powdered ore occurs. The ore is usually sufficiently concentrated, to be generally free from admixed clay and other foreign materials; and it requires practically little or no washing before shipping.

Analyses of two separate carloads of this ore were kindly furnished the Survey by Capt. John J. Calhoun, of Cartersville, Ga.; they are as follows: —

	Per Cent.	Per Cent.
Manganese	40.310	41.410
Silica	3.760	4.500
Phosphorus	0.127	0.134

Some manganiferous iron ore occurs associated with the deposits of manganese on this lot, as is shown in the following analysis of specimens, by Mr. A. S. Reed, of New York City: —

	Per Cent.
Manganese	15.260
Iron	39.250
Phosphorus	0.193

Mr. Reed also gives the results of a partial analysis of the manganese ore on this lot, as follows: —

	Per Cent.
Manganese	48.280
Phosphorus	0.127

Lot 260. — One shaft, 60 feet deep, was sunk some years ago near the southeast corner of this lot, and several test-pits were opened near by. The shaft is reported to have pierced a good grade of admixed fine and coarse gravel ore. All this was in the nature of prospecting, and no ore was shipped. Ocher is exposed in one of the test-pits. Samples of the manganese ore from the shaft gave Mr. A. S. Reed, of New York City: —

	Per Cent.
Manganese	25.090
Iron	29.170
Phosphorus	0.155

Lot 330. — Several openings on this lot have been worked about midway up a high and steeply sloping quartzite ridge. One of the

cuts has been recently worked, and one carload of the ore shipped. The ore was cleansed by means of a hand-washer located in the valley at the base of the ridge. Large deposits of brown iron ore occurring on this lot have been somewhat extensively worked.

Lot 306. — This lot occupies the top and a part of the northeast and southwest slopes of a high and steep northwest-southeast trending quartzite ridge. It is the nearest lot, owned by the Blue Ridge Mining Company, to the Dobbins mines, which have been the largest producers in the Cartersville district. The main openings are near the top of the ridge on the northeast slope. They include cuts, from the bottoms of which, shafts have been sunk, and some additional smaller test-pits near by. Ore is found on the southwest side of the ridge in the same lot, as is shown in several test-pits. The cuts, which are all large, were worked to some depth, attesting the removal of considerable ore. Two of the cuts were recently worked, and from these six carloads of ore were shipped.

The ore is of superior quality, comprising mostly crystallized gravel, and nodules of larger size. It is enclosed in the residual yellow clay in the form of small nests and pockets. Practically no clay is mixed with the ore in the pockets; and it requires little or no cleansing before shipping. A large quantity of ore was still visible along the faces of all the cuts.

Analyses of two carloads of the ore from this lot, furnished the Survey by Capt. John J. Calhoun, of Cartersville, Ga., show: —

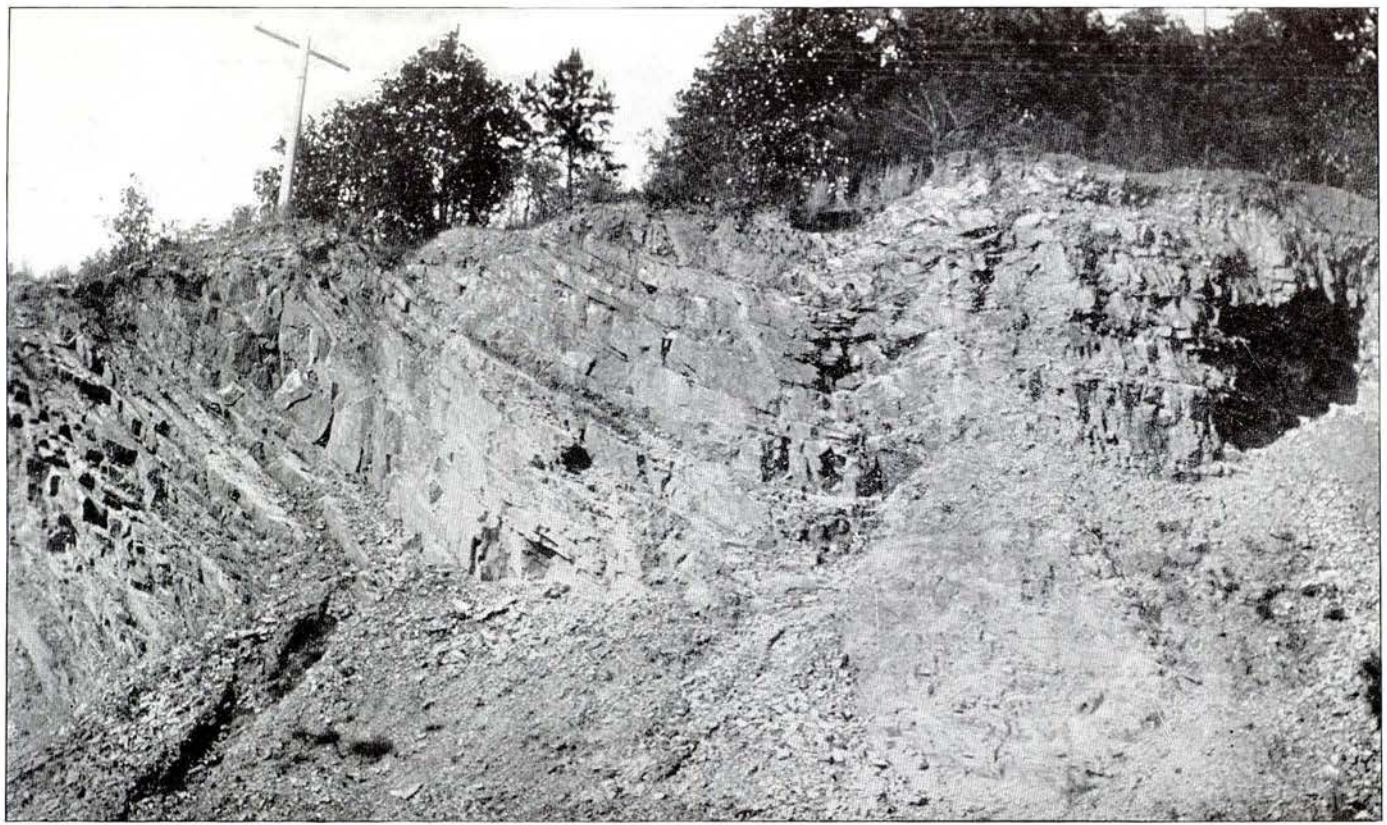
	Per Cent.	Per Cent.
Manganese	49.32	39.24
Silica	3.78	14.50[1]
Phosphorus	0.208	0.154

Samples of the ore from the same lot, collected by Mr. A. S. Reed, of New York City, gave, on analysis: —

	Per Cent.
Manganese	35.320
Iron	3.110
Phosphorus	0.063

Lot 305. — This lot lies immediately north of lot 306, and is

1 Not freed from adhering clay.



AN EXPOSURE OF WEISNER QUARTZITE ALONG THE WESTERN & ATLANTIC RAILROAD, AT THE IRON BRIDGE OVER THE ETOWAH RIVER, 1 MILE EAST OF CARTERSVILLE, GEORGIA, SHOWING THE CRUSHING AND FOLDING OF THE QUARTZITE

located on the northeast slope of the same ridge. It has been prospected, and ore of the same character and quality found, as that occurring on lot 306. No ore has been shipped.

Lot 303. — Much ore of superior quality has been mined on this lot. The first mining done was directly after the Civil War. It was apparently all open-cut work, and was nearly entirely filled-in, at the time of my examination. Work was again resumed in 1893. The larger cut and several shafts, from 30 to 40 feet in depth, from which drifts were run at different levels, comprise the mining done on this lot in 1893. Pockets of a high-grade, massive and crystallized ore, similar to that mined on lot 306, were worked. Smaller prospect openings are to be found over most of the lot, with good faces of ore exposed in each. Gray specular-iron ore has been worked to a limited extent on this lot, near the manganese openings.

Samples of the manganese occurring on the lot, collected by Mr. A. S. Reed, of New York City, gave on analysis: —

	Per Cent.
Manganese	54.940
Iron	3.620
Phosphorus	0.034

The following are the results, on analysis of ore from this lot, made by Professor H. C. White, of the State University, at Athens, Georgia: —

	Per Cent.
Manganese Dioxide, MnO_2	87.960
Alumina, Al_2O_3 / Iron Sesqui-oxide, Fe_2O_3	2.520
Silica, SiO_2	8.350
Sulphur, S	0.008
Phosphorus, P	0.120
Water, H_2O, and Organic Matter	1.042
Total	100.000

Equivalent in metallic manganese 54.975 per cent.

Lot 274. — This lot joins lot 303 on the west, and both are located on a northeast-southwest trending quartzite ridge. The only mining on the lot was done shortly after the Civil War. On account of

long standing, no ore in place was visible. The ore mined was cleansed by screening near the openings, which resulted in a total loss of all the finely divided ore. A large proportion of the dump-piles is composed of this finely divided ore. Gray specular and brown iron ores occur in close association with the deposits of manganese on the lot.

Lot 616. — This lot is located on the western slope of a high and steep quartzite ridge. About midway up the slope, one tunnel has been driven directly into the ridge for a distance of 215 feet. An excellent showing of a partially crystallized manganese gravel ore is exposed in the tunnel. A good deposit of yellow ocher and a three-foot vein of gray specular iron ore were also encountered in driving the tunnel, which was run for the purpose of working the vein of specular hematite.

The rock sequence in the tunnel beginning at the entrance is: —

	Feet
Vari-colored clays, the light-yellow siliceous clays predominating, with some intermingled quartzite fragments in all stages of decay	75
Yellow ocher and ochreous clay	10
Light-colored clays with quartzite fragments	35 (?)
Manganese ore-bearing clay	25
Light-colored clays with quartzite fragments	75 (?)
Vein of gray specular hematite	3
Total	215

Specimens of iron ore from the vein of specular hematite gave, on partial analysis: —

	Per Cent.
Metallic Iron	65.56
Silica	9.38
Phosphorus	none

Lot 759. — Near the bottom of the western slope of a high quartzite ridge, one open-cut, from 50 to 60 feet long, 15 feet wide, and from 10 to 15 feet deep, was worked some years ago. The cut exposes a deep residual clay, in which the manganese is embedded. Such ore as was visible appeared to be of good quality. The quantity of ore shipped could not be ascertained; but it was probably small.

LOT 755. — The surface indications for manganese ore are favorable over parts of the lot. Several small test-pits have been dug. No ore has been shipped.

LOT 171. — Mining on this lot consists of one circular-shaped pit, ten or more feet in depth, from which several small tunnels have been run in different directions. The character and mode of occurrence of the ore on the lot are the same as that described on lot 172, which joins *lot 171* on the east. The pit opened on *lot 171* is within a dozen paces of the east line passing between the two lots, and is only a short distance west of the most extensive opening on lot 172. A small cut has been made near the pit on *lot 171*, which exposes a manganiferous-iron-quartzite breccia. The breccia is a very large boulder-looking mass, of which the manganese and iron oxides enclosing the fragments of quartzite compose the larger part.

A tunnel, 50 feet in length, driven lower down the slope of the ridge into the pit, exposes excellent ore in places. Outcrops on the ridge-slope, many feet below the highest point at which the ore has been worked, show the ore-deposits to be extensive on this lot. The ore is principally pyrolusite, of the partially crystallized nodular type, with some fine gravel.

Specimens of the ore, collected from this lot by Mr. A. S. Reed, of New York City, gave, on analysis: —

	Per Cent.
Metallic Iron	28.213
Metallic Manganese	21.431
Phosphorus	0.322

As indicated by this analysis, long exposure to weathering has impregnated the manganese ore with iron oxide, from the limonite above.

LOT 174.—Considerable mining has been done on this lot, and much ore is still visible throughout the workings. The ore-bodies are rather extensive, and the ore is of about the same quality as that occurring on lot 171, described above. The development consists of a single large cut, opened in the valley bottom, and a 40-foot shaft, from which a drift has been run 60 feet in length, nearly connecting with the cut. The opposite slope of the valley-side has been

tested with a drill, and from 30 to 40 feet of gravel ore was reported to have been found at moderate depths. Some barytes was found in the boring.

Analyses of samples of the manganese ore from this lot gave Mr. A. S. Reed, of New York City: —

	Per Cent.	Per Cent.
Manganese	47.240	41.980
Iron	———	16 220
Phosphorus	0.155	0.227

THE BARTOW IRON AND FURNACE COMPANY'S PROPERTY

The office of the Bartow Iron and Furnace Company is in Cartersville, Ga. The Company owns the following north-south tier of 160-acre (?) lots in the 4th district, 3rd section of Bartow county, within one mile east of Emerson, Ga.: Nos. 758, 827, 830, 831 and 903.

The lots are located on the east side of a high and steep quartzite ridge, which trends a few degrees east of north. All the lots have been worked, to a limited degree, for manganese, and a few carloads of the ore have been shipped. The usual method of open-cut and tunnel work was employed in removing the ore. The openings are all small, and the work was done several years ago.

The openings begin near the base of the ridge in the valley on *lot 830*, and continue in a nearly north-south direction over *lot 827* to *lot 758*, where near the top of the ridge the largest openings occur. Two small cuts on *lot 758* are connected by drifts. Small test-pits have been sunk over most of *lot 827*. "Float" ore is found over the greater part of the surface of these lots.

The ores are enclosed as small pockets and stringers, and nodules and gravel, in both red and yellow residual clays, which contain a large admixture of broken fragments of quartzite. On *lot 758* much dark-chocolate colored clay, commingled with broken quartzite fragments, occurs. Coarse gravel and nodular ore predominates on *lots 830 and 827*, with the fine gravel type prevailing on *lot 758*. The work was done some years ago; and, at the time of my examination, the excavations had caved in, leaving but little to be seen. The gravel ore, composing the dumps near the openings on *lots 827 and 830*, shows much enclosed silica.

Where the Bartow-Emerson highway crosses *lot 903,* is seen a good exposure of manganese ore-bearing clay, studded, in places, with gravel and nodules of the ore. Surface indications for manganese are also favorable on *lot 831.* Brown iron ore has been extensively mined on *lot 903,* and much of the ore has been shipped. No prospecting has been done on *lots 831 and 903.*

Near the middle portion of the east slope of the north-south ridge, occurs an extensive deposit of brown iron ore on *lot 758.* The deposits of brown hematite were worked on this lot, some twenty years ago. The manganese ores occur on the west side of the lot; and, higher up the ridge-slope from the deposit of iron ore, the two ore-bodies appear to lie adjacent to each other; but, so far as they can be traced, they do not grade one into the other.

The ridge surface is strewn with large and small fragments of the quartzite in various stages of decay, most of which, however, is still hard and firm, but partially discolored, rock. A dense undergrowth covers the entire ridge-slope.

THE STEGALL PROPERTY

The Stegall property, owned by Mr. John P. Stegall, of Emerson, Ga., includes the following 160-acre lots of land in the 4th district, 3rd section, of Bartow county, near Emerson, on which manganese ores occur: — Nos. 826, 835, 895, 905, 906, 907, 908, 909, 979, 980. No prospecting has been done for manganese ores on a majority of the lots. *Lots 826, 895, 905 and 906* have all been prospected and worked for manganese. An excellent deposit of yellow ocher, also, has been opened on *lot 905.* On the remainder, surface indications of manganese ore, in the form of "float" ore, are present. The indications are especially strong on *lots 979 and 980.*

Manganese mining on this property has been confined chiefly to three *lots, namely, 826, 905 and 906. Lots 905 and 906* can best be described together, since the ore-bodies represent the same deposit; and the work has been continued from one lot into the other. The work is of about equal extent for the two lots, and is confined to an area along the dividing line between the two.

LOTS 905 AND 906. — The line separating these two lots passes approximately through the center of the area worked. Mining was first begun in 1885, and has been continued, at intervals, to the

present time, the work having been under lease by different parties. The openings occur on the low and gentle slope of a quartzite knoll, just beyond Emerson, a station on the Western and Atlantic railroad, five miles east of Cartersville. Approximately one hundred carloads of lump and gravel ore are reported to have been shipped from the two lots. A vast deal of work has been done, all of which is in the form of open cuts, tunnels and shafts.

The ore is distributed through both red and yellow clays. The former averages from two to five feet in depth, and overlies the yellow clay. The yellow clay, however, is the principal ore-producing clay. The manganese ores on *lot 905* are in close association with a large deposit of yellow ocher, of excellent grade.

Lot 826. — The surface indications of manganese ore are exceptionally favorable on this lot. It was first worked in 1892. The work includes one open-cut, with north and south drifts leading from it. The ore is composed largely of massive-crystalline lump, with but little fine gravel mixed with it. It occurs in pockets and small nests in the residual clay. Both the red and the yellow clays occur in a similar manner to that described on *lots 905 and 906*, the latter being the principal ore-bearing clay. Several carloads of the ore have been shipped.

Lot 895. — Two cuts, a large and a small one, containing mostly gravel ore have been worked. The greatest depth reached is in a shaft, 30 feet deep, in which the show of ore is reported to be good. Partially crystallized gravel ore is the chief type. Quartzite fragments are abundant in places, and are partly cemented by the ore in the form of breccia. The grade of the ore is said not to average as well as that on lot 826. Less than fifteen carloads of the ore have been shipped.

Lot 896. — No surface indications of ore have been observed on this lot. A well drilled for water is said to have passed through some manganese ore, of good quality.

Lots 826, 835, 907, 908, 909, 979 and 980. — Slight indications of manganese ore appear on the surface of these lots as "float" ore. The indications on *lots 979 and 980* are better than on the other lots. These lots have not been prospected for manganese; but *lots 835, 907, 908 and 979* were prospected for yellow ocher with splendid results.

THE CHUMLEY HILL PROPERTY

The Chumley Hill property is located from eight to ten miles slightly east of north from Cartersville, and is owned at present by the Southern Mining Company, of which Mr. Joel Hurt, of Atlanta, is president. The Southern Mining Company's property comprises the following 160-acre (?) lots of land in the 22nd district, 3rd section, of Bartow county, on which manganese ores occur: — Nos. 109, 143, 144, 146, 147 and 148.

The Chumley Hill property was first worked by the Pyrolusite Manganese Company, and, later, by the Dade Coal Company. Several lots, adjoining these owned by the Southern Mining Company, were worked at the same time, by the two companies mentioned above. This is especially true of *lots 314 and 315,* known, respectively, as the Bufford and White lots, which were extensively worked, and produced a large quantity of the ore. The production, here given for the years 1885 and 1886, includes ores mined by the Dade Coal Company on the Southern Mining Company's lots, and the White and Bufford lots, and perhaps others in the same section. The same is true of the chemical analyses of the manganese ores quoted below. The Chumley Hill mines have been one of the largest producers of manganese ores in the Cartersville district. In 1885, the mines produced one hundred tons of ore, which increased, in 1886, to a total output for the year of 2,654 tons.[1]

The following analyses will serve to indicate the variation in chemical composition of the ores from this locality.[1]:—

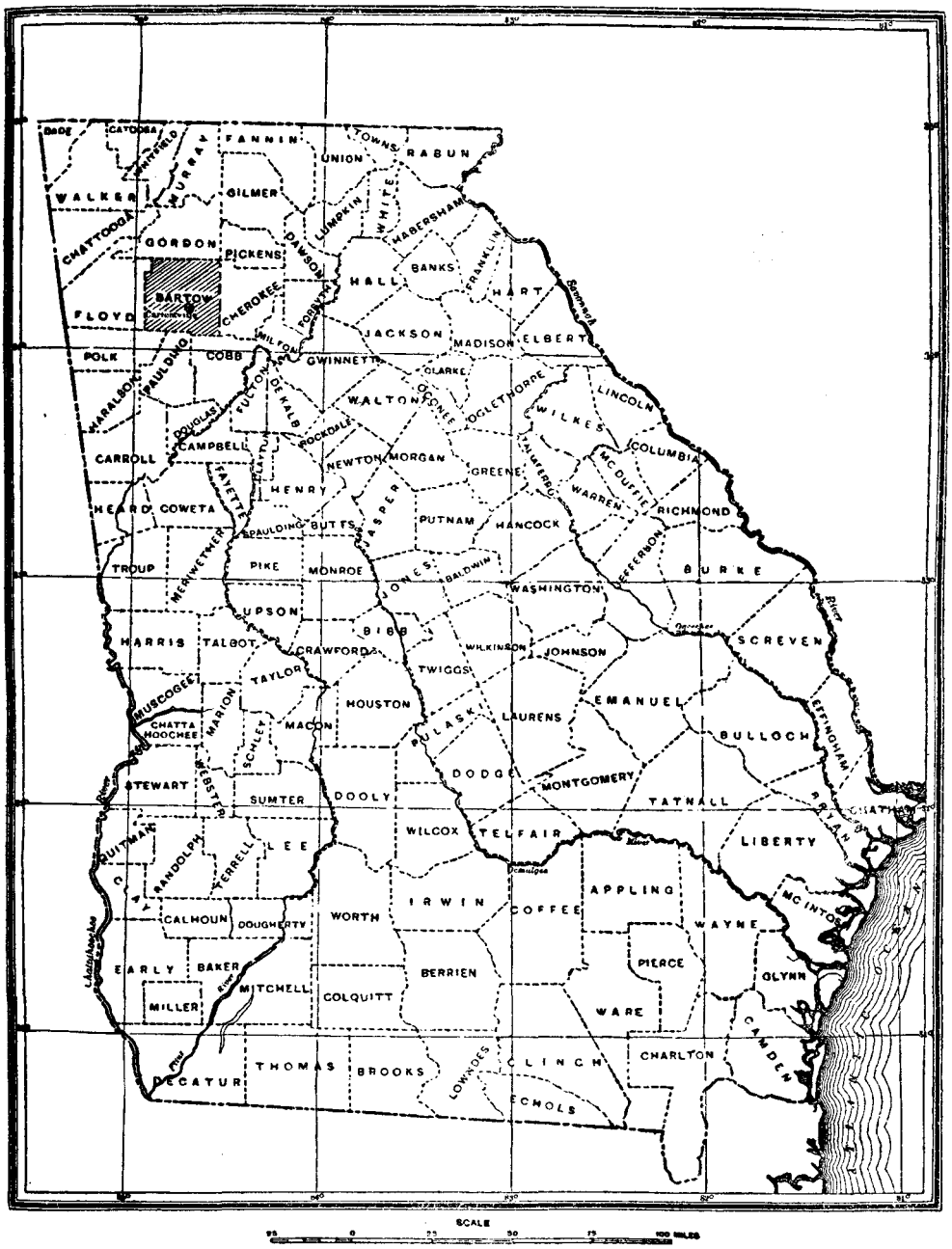
Manganese Per Cent.	Iron Per Cent.	Silica Per Cent.	Phosphorus Per Cent.
30.320	23.900	6.370	0.100
36.489	15.836	7.560	0.089
40.354	3.286	17.490	0.119
41.430	11.055	7.520	0.215
36.950	10.956	11.370	0.167
27.711	25.250	9.450	0.123
42.933	8.534	12.300	0.109
42.612	4.216	17.370	0.106
41.655	6.292	20.151	0.134
39.226	10.341	14.100	0 179
43.457	4.267	16.450	0.103

[1] Mineral Resources of the United States for 1886, p. 186.

Lot 143. — This lot was worked some years ago, near the center of the north line and on the south side of a quartzite ridge. One main cut, not exceeding 25 feet in depth and 50 feet in length, from the bottom of which a shaft was sunk, comprises the development. The examination was unsatisfactory, on account of the long standing of the work when it was visited by the writer. The dumps indicated a hard, concretionary, nodular ore, occurring in yellow clay. The ore is reported to average high in phosphorus and very high in silica. It was accordingly low grade. The writer was informed, that approximately 1,000 tons of ore had been shipped from this lot. The opening is known as the Moccasin Mine.

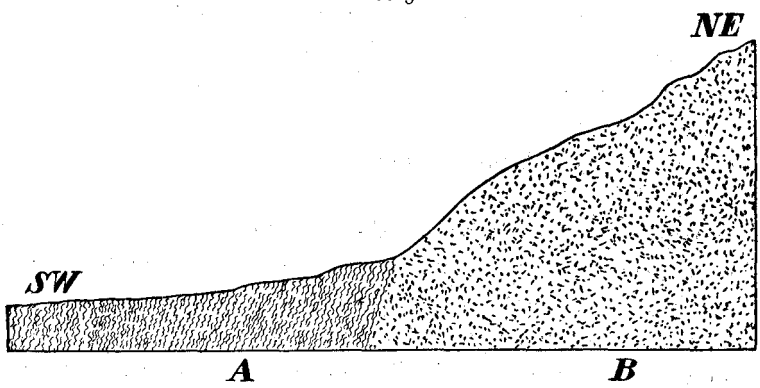
Lot 144. — This is the most extensively worked lot for manganese ores in the Chumley Hill section. It was worked at two different periods. The first work was done some years ago, near the northeast corner of the lot, the ore being mined from large open-pits or cuts, now known as the Old Chumley Opening. This opening consists of an open-cut, 300 feet long, 30 feet wide, and 10 feet deep. A shaft, 80 feet in depth, was sunk from the bottom of the cut. A new shaft, which had reached the 80-foot level, was being sunk in the cut, near the old one, at the time of my visit. Large concretionary nodules of the ore were found near the surface. The ore occurs in pockets of large size, and is mixed with more or less clay. The shafts are located a little distance from the ore-bodies, and cross-cuts are run from the shafts to the ore pockets, for removing the ore. The ore is enclosed in a light-colored, siliceous clay, derived from the decay of the Weisner quartzite. The openings are in the clays, derived from the decay of the Weisner quartzite, and about one mile east of the contact with the Beaver limestone. The washer is located only a short distance from the cut.

The New Chumley Mine consists of recent work done on the south side of and near the center of *lot 144*, from a quarter- to a half-mile southwest of the Old Chumley Mine, described above. Developments, here, include an open-cut, from 40 to 50 feet long, 20 feet wide, and 20 feet deep, with a 40-foot shaft sunk from the bottom of the cut. Most of the ore was taken from the cut, and only a small quantity came from the shaft. The ore-body was in the



General Map of Georgia Showing Position of Bartow County.

FIG. 5

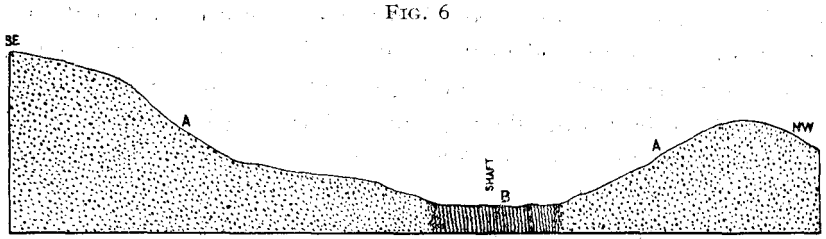


Section through the Bishop Mine, Georgia, Showing the Mode of Occurrence of the Manganese-bearing Clay (Penrose, page 472). A. Manganese-bearing Clay. B. Sandstone. *Horizontal Scale: 1 inch=300 feet. Vertical Scale: 1 inch=60 feet.*

form of a pocket, which pinched out at only a slight depth from the surface.

The ore-bearing clays occupy a hollow between two quartzite hills, and contain the ore in irregularly scattered pockets. The accompanying figure shows the mode of occurrence of the ore-bearing clays.

FIG. 6



Section through the Chumley Hill Mine, Bartow County, Georgia, Showing the Mode of Occurrence of the Manganese-bearing Clay (After Penrose). A. Sandstone. B. Manganese-bearing Clay. *Horizontal Scale: 1 inch=1 mile. Vertical Scale: 1 inch=400 feet.*

LOT 146.—Some half-dozen small pits have been worked near the base of the south slope of a high and steep quartzite ridge. One cut was opened opposite and near the Moccasin bank, on *lot 143*. It contained small pockets of botryoidal, nodular ore, mixed with

much of the earthy oxide enclosed by the residual clay. These pockets were soon exhausted. The openings on this lot have an approximate east-west alignment. The ore was a low-grade one, averaging high in phosphorus. Some 300 tons of the ore are reported to have been shipped. The openings are known as the RED MOUNTAIN MINE.

LOT 109.—This is known as the BIG SPRING lot. It has been worked to some extent for manganese ores in the southeast corner. One small cut, 50 feet long and 100 feet deep, was opened on the southeast side of a quartzite ridge, and a low grade of earthy oxide and fine gravel ore was mined. The cut is almost entirely in a white clay, and passes, at a slight depth, into the hard and firm quartzite. Less than a dozen carloads of this ore were shipped.

LOT 147.—*Lot 147* is known as the ALLISON lot. On the south slope of an east-west trending quartzite ridge, half-a-mile northeast from the Moccasin bank, some half-dozen test-pits have been sunk to a depth of a few feet in a deep-red residual clay. Several pits exposed a quartzite breccia of manganese and iron oxides, of very inferior quality. The surface indications for manganese ore are poor.

A cut, 30 feet in length and 15 feet deep, 300 yards west of the Peachtree bank, has been opened in the southeast corner of the lot, near a small stream, and in yellow clay. The ore is of the nodular type, and is reported to average high in phosphorus. Several small test-pits have been dug about a hundred yards west of the cut, all of which indicate some ore. Only a small quantity of ore has been shipped from this lot.

LOT 148.—*Lot 148* is referred to as the PEACHTREE lot. Two cuts, of about the same dimensions as the one described above on the Allison lot (147), were opened twelve years ago or more, in the southwest corner of the lot. The ore is of the usual nodular type, and averages high in phosphorus. It shows in a number of test-pits dug near the cut. The total shipment from this lot has been five carloads.

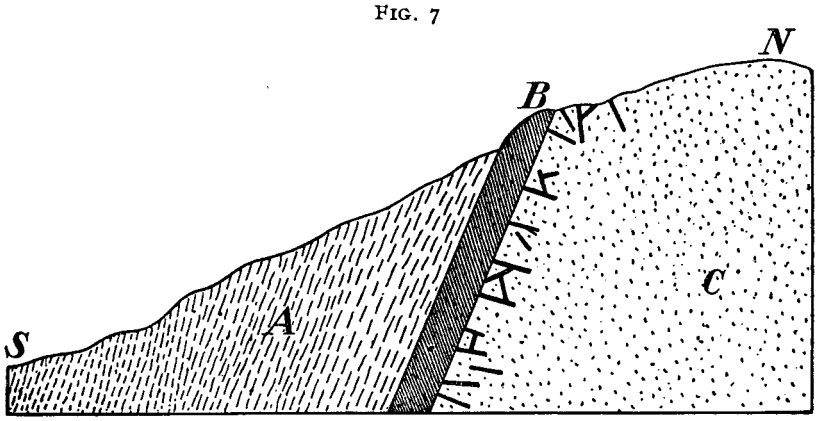
THE COLLINS LOT

Lot 214, 22nd district, Bartow county, is located near the base of the western slope of Sugar Hill mountain, a high quartzite ridge,

which has an approximate north-south trend. It has been prospected over most of its parts, as is shown by the numerous test-pits, only a few of which showed manganese ores. The principal opening is a cut, 200 feet in length and from 50 to 75 feet in width, which was opened within 200 yards of the Sugar Hill Iron Mines railroad. Much ore has evidently been removed from the cut. The excavation exposes both red and yellow clays, through which the ores are distributed in the form of scattered nodules and grains, concentrated at times in small pockets and nests, and connecting stringers. Considerable ore, of apparently good quality, was seen along the walls and bottom of the cut.

A second cut, of shallow depth, is opened near a shanty on the same lot, and about a quarter of a mile northeast of the large cut. Only slight indications of ore appear in it.

FIG. 7



Section through the Layton Mine, Georgia, showing the Mode of Occurrence of the Iron and Manganese Deposit (Modified from Penrose). A. Manganese-bearing Clay containing Ore in nodules and layers. B. Iron and Manganese Ore stratum. C. Sandstone. *Horizontal and Vertical Scale: 1 inch= 50 feet.*

MRS. N. E. MAHAN'S LOT

On *lot 291, 22nd district,* Bartow county, a test-pit was dug, some years ago, in the residual red clay of the Knox dolomite, two miles northeast of the Sugar Hill mining camp. The surface indications on this lot are better for iron than for manganese ores. The lot will prove of no value for manganese mining.

THE LARAMORE PROPERTY

This property includes two 160-acre lots in the *4th district, 3rd section* of Bartow county, located two and a half miles east of Cartersville, and within a mile of the Western and Atlantic railroad at Etowah station. The two lots adjoin each other, and are near the Etowah river, which insures an abundant supply of water for mining purposes.

LOTS 471 AND 472.—Manganese ores occur on both lots; but developments are confined almost exclusively to *lot 472,* on which considerable prospecting has been done, in the nature of cuts, tunnels and pits. Something like a dozen openings, from which more or less manganese ore has been taken out, have been worked on the north, east and west sides of *lot 472.* The largest cut will average 100 feet in length, from 6 to 8 feet wide, and from 10 to 15 feet in depth. The ore is enclosed in the residual clays, derived from the Weisner quartzite, in the form of stringers, irregular small pockets, and scattered nodules. Both crystallized massive and gravel ores occur. Some of the earthy oxide, wad, is found. The gravel and massive types of ore occur in about equal proportions, with a larger proportion of admixed clay in the former type. Red, yellow and dark-chocolate colored clays, and, to a much less extent, white clays, compose the residual rock-decay on this property. The ores are almost entirely limited to the yellow and dark-chocolate clays. The surface clay is a prevailing red clay, which is admixed with abundant quartzite fragments, some of which will measure from 10 to 15 feet in diameter. These quartzite fragments are usually impregnated with the manganese oxides; and quartzite breccia, cemented by manganese and iron oxides, is met with, in places.

Chemical analyses, made by the Illinois Steel Company at Chicago, from samples of the ore collected by Mr. W. P. Laramore, gave the following results:—

	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Manganese	50.83	53.140	47.600	41.280
Iron	2.94	1.410	6.500	4.240
Silica	7.36	1.350	2.150	10 880
Phosphorus	0.16	0.074	0.182	0.159

Analyses of specimens of the manganese ores, from *lot 472,* made by the Tennessee Coal and Iron Company, gave : —

	Per Cent.	Per Cent.
Manganese	56.400	53.610
Iron	1.290	1.290
Silica	0.650	1.130
Phosphorus	0.158	0.154

A good deposit of yellow ocher extends across *lots 471 and 472,* and is in close association with the manganese ores. The ocher is exposed in a number of test-pits dug on the two lots. Deposits of limonite were extensively worked on *lot 471,* prior to the Civil War, by the Mark A. Cooper Iron Company.

Slight surface indications of manganese were observed in the northeast corner of *lot 538,* along the track of the Blue Ridge Mining Company's railroad, at the base of a steep quartzite ridge.

THE LARAMORE, DANIEL AND STEPHENS PROPERTY

Lot 506, 21st district, and *lot 172, 4th district* of Bartow county, constitute the mining lots on this property. Manganese mining has been limited entirely to *lot 172.*

LOT 506.—*Lot 506* has not been prospected for manganese; but numerous test-pits for iron ore have been dug. Only slight indications of manganese ores have been observed.

LOT 172.—*Lot 172* is known as the FRANKLIN LOT. Manganese ores have been mined from some half-dozen cuts, shafts and tunnels, in close proximity to each other. The principal excavations are all located in the west half of the lot; but numerous test-pits have been dug in other parts. A large quantity of ore has been shipped from this lot. The lot is located on the slope and near the top of a high and steeply sloping quartzite peak near Cartersville. Its surface is heavily covered, in places, with large and small angular fragments of the quartzite. A short distance back of the openings, and on top of the peak, the quartzite outcrops as hard and firm rock, cut by joint-planes. Weathering has progressed along the planes to such an extent, that the exposure presents the appearance of a huge pile composed of large individual blocks and masses.

The greatest depth reached in mining is in a thirty-foot shaft, which is reported to have encountered ore for its entire depth. The ore is distributed through the residual clay as thin sheets, stringers and small pockets, and, to some extent, as scattered grains and nodules. Stratification is evident in the clays, conforming in a general way with the slope of the peak. The ore-bodies conform in a general way to the stratification planes and the dip of the clay layers, often, however, cutting at angles to these directions. Fine gravel and nodular types of the ore predominate. The ore begins at the surface, and is continuous below the depths reached in mining on the lot. Red, yellow and dark-colored clays are exposed in the excavations, and are admixed with large proportions of the quartzite fragments. These fragments are entirely angular, and are enclosed in the clays, without conforming to the directions of stratification; but, like the ore-bodies, they are found cutting across the clay layers with much irregularity. All stages of decay are represented; from the hard and firm only partially discolored rock to fragments, which readily crumble under the gentlest pressure into a pulverulent mass of white, red and brown sand. The ore is more abundant in the yellow clay, than in the red and dark-colored clays. Back from the main working area, a short distance, and near the top of the peak, a pit, less than two feet in depth, was sunk. The comparatively fresh rock was exposed in the bottom. In this opening, much of the fragmental quartzite is cemented by the oxides of manganese, in the form of breccia.

Deposits of both limonite and yellow ocher are more or less intimately associated with the ores of manganese on this lot. A large quantity of manganese ore was observed along the walls and, in some cases, the bottoms of the excavations. About 100 carloads of ore are reported to have been shipped from this lot.

THE R. B. AND G. W. SATTERFIELD PROPERTY

The Satterfield property includes *lots 259 and 318, 4th district* of Bartow county, both of which were being worked at the time of the writer's examination. The lots join each other, and are located on the north slope of an approximately east-west trending quartzite ridge.

LOT 259.—The principal work done is near the basal slope of the ridge, and includes open-cut and tunnel work. Three cuts, averaging from 20 to 40 feet in length, 5 feet wide, and from 12 to 20 feet in depth, have been worked. One tunnel, which was being worked at the time of the writer's visit, had been driven directly into the ridge, from near the base to a distance of about 50 feet. Besides this work, the lot has been largely prospected for manganese ore in other places, and some ore is exposed in most of the pits.

The surface material is a deep-red clay, averaging from three to six feet in depth, and is underlain by the lighter-colored yellow clay. In addition to the red and yellow clays, those of a white and dark-chocolate color are intermingled, in places. The yellow clay is the principal ore-bearing clay, through which the ores are distributed as small irregular pockets and stringers, and as single scattered nodules and smaller grains or gravel. The nodular ore is usually entirely or partially crystallized. It is estimated, that 600 tons of ore have been shipped from this lot. It is a high-grade ore, averaging low in phosphorus, silica and iron.

LOT 318.—*Lot 318* joins *lot 259* on the east side. It has been extensively worked and prospected for manganese ore. The work begins near the base of the ridge in the valley, and extends nearly half the distance up the ridge-slope. Three open-cuts, of approximately the same dimensions as the ones described on *lot 259,* have been worked. A shaft, 53 feet deep, has been sunk, from which one carload of ore was removed. Ore, ten feet thick, was found in the shaft at a depth of 25 feet, a three-foot face being exposed in the bottom of the shaft. The shaft was sunk more for prospecting than for systematic work. One tunnel has been driven into the ridge near the water-level in the valley, for a distance of from 40 to 50 feet. Three carloads of ore were taken from it.

The associated clays are of the same kind and character, as those described on *lot 259;* but the ore differs from the ore on that lot, principally in being of the nodular rather than the fine-gravel type. Its mode of occurrence and association are much the same for the two lots. In addition to the larger openings, numerous small test-pits have been dug over most of the lot, the majority of which show

some ore. The ore averages low in phosphorus; and, in other respects, it is similar to that occurring on the adjacent lot, 259.

Small quantities of limonite occur, in places, on the two lots, in association with the manganese ores; but it is probably not workable. Some yellow ocherous clay is found on *lot 259;* but, as yet, no indications of workable ocher appear.

A manganese washer is located in the valley, a few rods from the openings on the two lots. It consists of a single log, 25 feet in length.

THE MANSFIELD BROTHERS PROPERTY

This property is located several miles east of Cartersville, near the Etowah river, and comprises the following 160-acre lots of land in the *4th district, 3rd section* of Bartow county, on which manganese ores occur: *Nos. 402, 403, 463, 615 and 682.*

LOT 402.—This lot is situated partly on the western slope of a quartzite ridge and partly in the adjacent valley. One open-cut, 25 feet in length, has been worked near the foot of the slope on the ridge, to a depth of 15 feet. The ore is here associated with both red and yellow clays, but mostly with the latter. Surface indications of manganese are present in other places over the lot. Three carloads of the ore are reported to have been shipped in 1887.

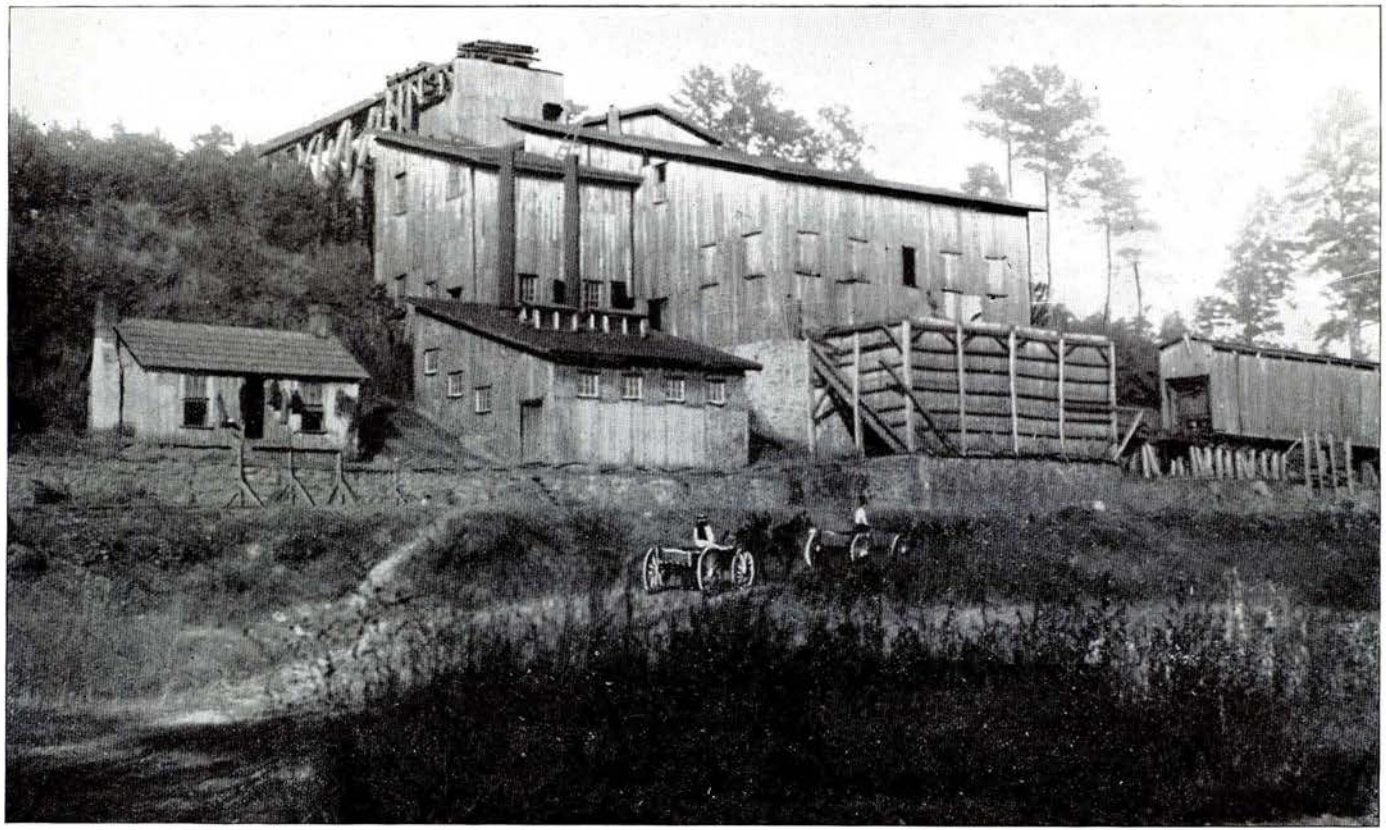
On *lot 403,* one small prospect opening has been made, about half way up the east slope of the quartzite ridge. From this, a few tons of ore are reported to have been shipped.

The two openings on *lots 402 and 403* are nearly opposite each other, on the adjacent slopes of two nearly parallel north-south trending ridges of quartzite. The openings were made some years ago; and, on account of long standing, they had so badly fallen-in, that nothing could be seen at the time of my visit.

Only surface indications of manganese are found on *lot 463.* No work nor prospecting has been done. Similar surface indications for manganese, mixed with considerable iron-ore "float," are reported on *lots 615 and 685.*

THE W. H. LANHAM PROPERTY

Lots 476 and 477, 4th district, Bartow county, are owned by Mr. W. H. Lanham. They are several miles east of Cartersville, on the



MANGANESE MILLING PLANT OF THE BLUE RIDGE MINING COMPANY, TWO AND A HALF MILES EAST OF CARTERSVILLE, GEORGIA

north side of the Etowah River. *Lot 476* has not been worked for manganese; but a large prospect opening has exposed a very promising deposit of yellow ocher.

In the southeast part of *lot 477,* some manganese ore was mined 15 or 20 years ago, and less than a dozen carloads of the ore are reported to have been shipped. A tunnel, 300 feet in length, was worked near the summit of a quartzite ridge, from the sides of which a number of drifts were worked. Several small cuts were dug near the tunnel. The ore was enclosed in red, yellow and dark-colored clays, as stringer veins and pockets. No ore was visible in place at the time of my examination; but the dumps showed both the nodular and fine gravel types. A deposit of yellow ocher is in close contact with the manganese ores.

THE N. P. LANHAM PROPERTY

Mr. N. P. Lanham's property joins that of his brother, Mr. W. H. Lanham, described above, on the east, and includes the following 40-acre lots in the *4th district, 3rd section* of Bartow county, on which manganese ores occur: *Nos. 475, 476 (east half), and 534.*

On *lot 475,* near the west side, an open-cut, ten feet long and five feet deep, has been worked in a deep red clay. One carload of manganese ore has been shipped from this cut. Numerous water-worn quartzite pebbles are admixed with the red clay in the cut. The ore comprises mixed gravel and small nodules, the larger fragments of which are cellular or spongy in texture. The cavities in the ore are entirely filled with the red clay, which requires very careful washing and, oftentimes, crushing, before the admixed clay is sufficiently removed to render the ore marketable. A number of test-pits are dug over the lot, exposing some manganese ore in each one.

In the east half of *lot 476,* some manganese ore was being mined, at the time of my examination, from a small cut, opened near the middle slope of a moderately steep but low quartzite ridge. The ore is enclosed as small nests and stringers, and as scattered nodules in the red clay, and is admixed with considerable barytes, in places. It is quite similar to that described above on *lot 475.* The ore is gen-

erally spongy in texture, and the cavities are filled with the red clay.

Both ocher and manganese occur on *lot 534*. No prospecting, except for ocher, has been done on the lot. Large deposits of an excellent grade of yellow ocher are exposed in a number of openings on all three lots. Prospecting has been more extensive on *lot 475*, where some ten or more openings reveal the quality of the material. In the main opening, much manganese and some micaceous iron ore occur in the body of the ocher. The capping consists of red and dark-colored clays freely admixed with decayed fragments of the quartzite. The partially decayed quartzite was encountered in this opening, at a comparatively slight depth, less than 40 feet. Probably, as much as 75 to 100 yards back of this opening, and on top of the ridge, where *lots 475 and 476* corner, the hard and firm quartzite outcrops for some distance over the surface of the two lots.

THE FREEMAN LOT

Lot 313, 4th district, Bartow county, is owned by Mrs. Mary J. Freeman, of Cartersville. It is located only a short distance out of Cartersville, on the Rowland Springs road; and it is slightly elevated above the road on a low, flat-topped hill. Manganese oxide mixed with limonite is exposed along the public road, for several feet near the lot. Manganese ores have been worked from five openings on the lot — three open-cuts, one shaft and one tunnel. The cuts will average from 10 to 30 feet in length, and are limited mostly to the surface residual red clay; but they cut the underlying yellow clay in several of the deepest places. The gravel type of ore predominates, admixed with more or less small nodules and large boulder ore. A small percentage of the ore is partially crystallized. "Float" ore is very heavy, over nearly the entire surface of the lot. This ore is made up of small fragments, which are generally light in weight; and, judging from their color, they will average high in iron oxide.

The opening near the base of the low ridge on the opposite side of the lot from the Rowland Springs road is in clay, exposing a reef of the hard and moderately fresh quartzite. The ore is inti-

mately associated with the quartzite, filling the fractures due to the crushing, in the form of veinlets and stringers, and cementing the broken rock fragments as quartzite breccia. Considerable halloysite, in the form of small irregular-shaped, but usually rounded, masses and lumps, is associated with the ore in this opening. Two carloads of the ore are reported to have been shipped from this opening.

On the south side of the lot, near the last described opening, a 30-foot shaft, from which several drifts lead in different directions, was worked some years ago, and six carloads of ore are said to have been shipped.

The following chemical analyses of the ore from this lot will indicate its general character: —

	Per Cent.	Per Cent.
Manganese	38.00	42.40
Silica	20.00	8.00
Phosphorus	0.10	0.10

THE SMITH LOT

Lot 226, 4th district, Bartow county, is owned by Messrs. J. B. and F. A. Smith, of Cartersville. It occupies a part of the west side of a gently sloping ridge, and adjoins the Freeman lot, *No. 313.* The developments consist of one open-cut, 15 feet deep, and one 30-foot shaft, with a 10-foot tunnel leading from it. The ore is of superior quality, usually crystallized large lumps and nodules, and some fine gravel, admixed, in places, with some fine pulverulent manganese oxide. It averages high in metallic manganese and low in phosphorus and silica. Its occurrence is that of irregular pockets and connecting stringers in the enclosing residual clay.

The deep-red surface clay will average about six feet in depth; and it is underlain by yellow and dark-chocolate clays. Some white clays are found, usually characterized by numerous slicken-sided surfaces. Only one carload of the ore has been shipped. A chemical analysis of this ore gave: —

	Per Cent.
Manganese	53.200
Silica	3.320
Phosphorus	0.146

THE HEATH SISTERS PROPERTY

This property comprises *lots 542 and 543, 4th district,* Bartow county, located along a deep ravine incised in a high and steeply sloping quartzite ridge, on the south side of the Etowah river, less than three miles from Cartersville. Much work has been done, and from 12 to 15 carloads of the ore are reported to have been shipped. The lots have been widely prospected, as is indicated in the numerous excavations, in all of which ore is exposed. The larger excavations are principally open-cuts, of large dimensions, worked to some depth, and several shafts. The ore is enclosed as nests and small pockets, and as stringers and scattered nodules and gravel, in light-yellow clay, which is largely admixed with quartzite fragments, of nearly all sizes. Both gravel and crystallized nodular ore occur admixed, with perhaps the gravel type predominating. The only objection urged against the ore is its uniformly high average in phosphorus, as is shown in the following analysis: —

	Per Cent.
Manganese	33.000
Silica	32.000
Phosphorus	0.329

The excavations on the Heath lots form some of the most extensive open-work in the Cartersville district. Large quantities of the ore are exposed in the bottoms and sides of the cuts. Limonite has been more or less extensively worked on several of the adjoining lots of land.

Lots 263, 265, 266, 315 and 330, 4th district, Bartow county, have been prospected for manganese ores, and ore is reported to have been found on each one.

THE BARROW LOT

Lot 405, 4th district, Bartow county, is a part of the Parrot Spring tract, and is within one mile of Cartersville. The principal opening is a large cut, situated a few rods below and to the right of the spring. It was worked some years ago, and, though much filled with the caving earth, considerable manganese ore is in sight. Mr. Barrow reports that 25 tons of ore have been shipped from this

lot. The ore formed pockets and large stringers in the enclosing clays. It was chiefly of lump and massive kinds, admixed, in places, with much iron oxide. Much of the ore exposed at present consists of mixtures of the manganese and iron oxides, forming manganiferous iron ore. The ore is in close association with deposits of yellow ocher, as is shown in the large cut and in other smaller excavations over the lot. A partial analysis of specimens of the ore from this lot, made in Chicago, gave : —

	Per Cent.
Manganese	47.23
Iron	4.85

THE GUYTON PROPERTY

The manganese ores on this property, *lot 235, 5th district,* Bartow county, were first worked some years ago by Mr. E. H. Woodward. Some work was being done at the time of my examination. Some half-dozen open-cuts have been worked for manganese ore. Limonite, which occurs intimately associated with the manganese on the west and south sides of the lot, has been largely worked. Fine and coarse gravel, larger nodular and some crystallized needle ore comprise the types of ore occurring on the lot. The general average of the ore is low in phosphorus and proportionally high in metallic manganese. It is distributed through the different colored clays in the usual occurrence. The residual clays extend to shallow depths over portions of the lot. In some of the openings, the comparatively fresh and hard quartzite is exposed. Where so exposed, it is much crushed and fractured, and is largely cemented by the manganese ores, forming breccia. The total shipment from this lot will aggregate less than 12 carloads.

THE G. W. SATTERFIELD PROPERTY

Lot 270, 5th district, Bartow county, lies immediately west of the Guyton lot, and it joins the Dobbins estate on the west. It is known as the LEWIS LOT. The surface indications for manganese ores on this lot are very favorable. Numerous test-pits have been dug, and manganese ores found in each one. Indications are equally

as good for iron ore, and a little gray specular ore was worked to a limited extent; but none was shipped.

THE F. A. AND J. B. SMITH PROPERTY

Lot 234, 5th district, Bartow county, joins the Guyton lot, 235, on the west, and occupies portions of the summit, and north and west slopes of the same quartzite ridge. Some half-dozen cuts were worked some years ago, on the north and northwest slopes of the ridge, from which apparently a good quantity of the ore was removed. The cuts are of average size. Some recent work has been done. The mode of occurrence, association, and character of the ore are the same, as that described for the Guyton lot.

THE FELTON LOT

Several prospect openings, of small size, have been made on *lot 27, 4th district,* Bartow county, which expose a manganiferous iron ore.

THE JONES BROTHERS LOT

Lot 331, 4th district, Bartow county, known as the MAHAN LOT, occupies a part of the south slope of a high and steep quartzite ridge, which has an approximate east-west trend. The surface of the ridge slope is thickly covered, in places, with the broken quartzite fragments. Less than half-a-dozen prospect openings have been made on the lot, near the top of the ridge. One shaft, opened to the depth of 15 to 20 feet, exposes a fair grade of yellow ocher. The surface indications are favorable, in places over the lot, for both manganese and ocher. The dumps indicate the usual type of nodular ore. Little or no ore has been shipped.

THE SMITH AND PEACOCK LOT

The east half of *lot 332, 4th district,* Bartow county, is owned by Mr. James M. Smith, and the west half by Capt. D. W. K. Peacock. It adjoins the Jones Brothers lot on the east, and occupies a part of the same slope of the quartzite ridge. One small cut has been opened on the east half of the lot, near the line with lot 331. This cut exposes ocher principally, and some manganese.

THE GEORGIA MANGANESE AND IRON COMPANY'S PROPERTY

This property includes lots lying on both sides of the Rowland Spring road, and is located three miles east of Cartersville. It comprises the following 40-acre lots of land in the *4th district, 3rd section* of Bartow county, on which manganese ores occur and have been worked: *Nos. 115, 175, 187, 188, 189 and 245.*

This property has been extensively worked for manganese, and large shipments of the ores have been made. The developments consist of eight large open-cuts and numerous smaller openings in the nature of test-pits. None of the cuts have been worked to any considerable depth. The work was all done some years ago, and the openings were mostly caved in at the time of my examination, making it difficult to see the exact nature of the deposits. Notwithstanding the above condition of the openings, indications are very favorable, in places, for much pay-ore still in sight, which could be easily worked at a small cost. The clay is generally of a chocolate, red or yellow color, sometimes pure white, and is admixed with quartzite fragments, of various sizes and in all stages of decay. The ore is distributed through the clays, as pockets of irregular shape and different sizes, and as stringers. From the character of the ore in the dump, it evidently consisted of gravel and concretionary nodules. The nodules are of various shapes and sizes, and are usually partially or entirely crystalline.

An excellent grade of yellow ocher occurs near the manganese ores on *lots 115, 187 and 188.* Several large prospect openings near the extensive outcrops of quartzite, expose the ocher on these lots. The openings occur along a deep ravine on the north side of the Rowland Spring road, and at the base of steep cliffs of the quartzite. At this point the quartzite is much fractured from pressure.

THE PEACOCK LOT

Lot 317, 4th district, Bartow county, is located on the southwest slope and near the base of the same ridge, and on the opposite side of the ridge from the Satterfield *lot, No. 318.* Some three or four pits, of small size, were opened near the base of the ridge in the southeast portion of the lot a number of years ago. From these,

some manganese ore was removed. The pits were shallow, and did not cut through the surface red clay. No ore could be seen in place, on account of the long standing of the pits, which had badly caved in. Surface indications in the nature of "float" ore occur over various parts of the lot.

THE PATILLO LOT

The PATILLO PROPERTY, *lot 312, 4th district,* Bartow county, is north of, and just beyond, the corporate limits of Cartersville. Openings for manganese ore have been made in four different places on the lot. The largest excavations are near the center of the lot and include open-cuts, pits and shafts. Some of these have been worked to a depth of 35 feet, the local water-level, below which it is necessary to use pumps for raising the water in mining. The ore is distributed mostly through yellow clay, and comprises both concretionary nodules and gravel, which are partially crystalline. The excavations are old, and had caved in, to so great an extent as to make it difficult to see the exact nature of the deposits. A large quantity of the ore is reported to have been shipped from the lot.

A chemical analysis of a select sample of the manganese ore from this lot, made by Carnegie, Phipps and Co., of Pittsburg, Penn., gave : —

	Per Cent.
Manganese	60.610
Iron	1 450
Silica	2 800
Phosphorus	0 052
Sulphur	none

A deposit of limonite crosses the lot, to the east of the manganese ore openings, and much of this iron ore has been worked and shipped.

THE STEPHENS PROPERTY

The principal manganese ore-deposits on the Stephens property are located near the summit of a rather high and moderately steep quartzite ridge, on *lot 931, 4th district, 3rd section,* Bartow county.

Large angular and subangular fragments of the quartzite are thickly strewn over the ridge surface. Both manganese and iron ores occur in close association on this lot. In the southwest corner of the lot, one open-cut, 20 feet long and 6 feet deep, has been dug on a large exposure of hard, massive and somewhat spongy manganese oxide. The cavities in the ore are filled with the red clay, in which the ore is embedded. The ore appears in some quantity. Smaller openings for manganese ore have been dug lower down the ridge slope and in the same quarter of the lot as the cut. The surface indications for manganese are favorable over most of the lot.

Limonite is exposed in several open-cuts and tunnels, made on the northeast side of the lot. Large quartzite masses, heavily impregnated with yellow ocher, and locally known as ocher "bloom," extend over parts of the central portions of the lot. The ocher in these masses makes up a large percentage of the rock as indicated in their yellow-brown to golden yellow color.[1]

On *lot 836, 4th district,* Bartow county, occur small quantities, of manganese ore associated with the large and extensive deposits of yellow ocher, shown in all the numerous excavations. This lot is a valuable one for its ocher, a description of which is given in the report on the ocher deposits.[2]

THE JOHN DOBBS ESTATE

Judging from the number of somewhat extensive excavations made on this property, *lot 760, 4th district, 3rd section,* Bartow county, a large quantity of manganese ore has been mined. The lot occupies a part of the summit and southeast slope of one of the innumerable quartzite ridges in the district. The work was done some years ago, and the exact nature of the deposits could not be made out. Some dozen openings, consisting of open-cuts, tunnels and one shaft, include the developments made on this lot. The longest cut is on the top of the ridge, and is 300 feet long, from 15 to 20 feet wide, and was worked to a depth of more than 15 feet. The excavations are of shallow depth, and are almost entirely

[1] For a description and analysis of the brown iron ore on this lot, see Bulletin No. 10-A. Geological Survey of Georgia, 1900, by S. W. McCallie, p. 116 *et s q.*

[2] Bulletin No. 13. Geological Survey of Georgia, 1906, by Thomas L. Watson.

limited to the surface covering of deep-red clay. From the character of the dumps, the ore was of good quality, and was admixed with more or less iron oxide.

Large scattered masses of the quartzite highly impregnated with yellow ocher, of the usual ocher-yellow color, found over the surface of the lot on top of the ridge, indicate the presence of ocher.

THE BLUE RIDGE OCHER COMPANY'S LOT

Lot 390, 4th district, Bartow county, was first worked for manganese ore in 1859, prior to the Civil War, and is said to have produced the first manganese mined in the State. Work was again resumed in 1866, after the Civil War, by Mr. A. P. Silva, when a large amount of the ore was mined and shipped. The developments comprised extensive open-cut work, shafts and tunnels over much of the lot. The entire surface of the lot is capped with an average depth of from six to eight feet of brick-red clay, underlain by a lighter-colored, yellow siliceous clay. The ore is distributed through both clays; but it is mostly found in the latter, in the form of small, irregular pockets and stringers, and as disseminated concretionary nodules and larger masses. It includes fine gravel and nodular ore, with scattered larger masses in the form of boulders. The ore was entirely cleansed and prepared for the market by screening. This method necessarily involved large losses in the escape of the fine gravel ore.

This lot was considered one of the best producers of high-grade manganese ores in the Cartersville district. The total yield was a large one. To-day, the lot is pre-eminently an ocher property, and yields no manganese; but it is one of the principal producers of yellow ocher in the district. During a visit to this lot, in the summer of 1902, the writer was informed by the manager, Capt. Postell, that manganese mining would likely be resumed on a part of the lot during the winter, as recent prospecting had revealed excellent deposits of the ore.

The two ores, manganese and yellow ocher, are intimately associated; and the openings originally used for mining the manganese are, with further extension, used in removing the ocher. No attention was given at first to the excellent deposits of yellow ocher;

and it is only within the past three or four years, that the ocher has been mined.

The covering of the residual clays thins toward the top of the ridge; and, in places on the ridge-crest, the quartzite outcrops in a chain of disconnected broken masses. Since the depths of the original manganese workings have been extended in mining the ocher, dark-colored clays are found freely admixed with the quartzite fragments. This clay, in places, is highly charged with the ocher, and oftentimes it passes or grades into the ocher proper.

THE MILNER-HARRIS PROPERTY

THE MILNER-HARRIS PROPERTY contains 550 acres of land, located five miles from Cartersville, from 20 to 30 degrees east of north. It joins the Dobbins estate on the north, and includes *lots 269 and 272, 50 acres of lot 273, and 100 acres of lot 267,* in the *5th district, 3rd section,* Bartow county. Manganese mining has been confined chiefly to *lot 272,* which occupies a part of the lower slope of a quartzite ridge, and a part of the valley adjacent. The surface of the ridge-slope is thickly covered with loose fragments of the quartzite, which, in some cases, are cemented by the oxides of manganese and iron forming breccia. Five shafts have been worked on *lot 272,* which range in depth from 40 to 110 feet. The shafts are located near each other, and a large quantity of high-grade manganese ore has been mined and shipped. The Stiles shaft, sunk in 1897-'8 to a depth of 110 feet, encountered ore at a depth of 20 feet below the surface, and continued, it is reported, in a good grade of ore, from the 20-foot level to the bottom, 110 feet. More than 100 tons of the ore per month, for one year, are reported to have been shipped to the Carnegie plant at Pittsburg, Penn., from this shaft alone. Drifts were worked at different levels, leading in different directions from many of the shafts. As is indicated in the shafts and other smaller openings on the lot, the workable ore is concentrated at some depth below the surface.

In the south half of *lot 272,* near the east line, an open-cut 30 feet in length and of slight depth, has been worked on an incline of approximately 15°. This opening is entirely limited to the deepred surface clay, indicating but little workable ore. Several hun-

dred rods distant from the shafts, higher up the ridge-slope and extending across the south line into the Dobbins *lot, No. 271,* is an extensive open-cut, from which considerable ore has been mined. Several shafts of slight depth were sunk from the bottom of the cut. North of this cut, 150 yards, is a second smaller pit, worked to an average depth of 50 feet.

In the fall of 1901, a 70-foot shaft was sunk, a few rods from a shaft, 76 feet deep, worked by the Etowah Company, some eight or nine years ago. The new shaft was sunk for the purpose of catching a 26-foot face of ore, removed, in three 6-foot drifts, from the old Etowah shaft. The shaft was also intended to work the ore-bodies below the level of the lowest drift in the old shaft. A 40-foot drift, run in a north direction from the bottom of the new shaft, caught one of the old drifts from the Etowah shaft, cutting into a pocket of concretionary, nodular ore, and exposing a 6-foot face of the ore. The ore-body was enclosed in yellow clay, and contained a large proportion of the clay admixed with the ore. Some white or light-colored clay, free from ore, was cut. This was derived from the decay of intercalated mica-slates. The stratification planes of the original rock are mostly preserved in the clays. The surface clay, which is red in color, will average 20 feet in depth, in places on the lot.

The ore is distributed through the clays in the form of pockets, lenticular masses and stringers. Concretionary-nodular and fine-gravel types of ore predominate. Much of the large lump or concretionary ore is partially crystalline, and is often admixed with fine grains and particles of quartz. The abundant quartzite fragments, distributed through the clays, are quite frequently cemented by the oxides of manganese and iron, forming breccia masses.

A chemical analysis of specimens of this ore, kindly furnished the Survey by Mr. Milner, gave : —

	Per Cent.
Manganese	52.730
Iron	4.490
Silica	4.300
Phosphorus	0.188

Lot 272 has been worked at intervals for many years, under lease

to different parties, and has been one of the principal producers of manganese ores in the Cartersville district. The production has been large, and the ore was of good quality. A log-washer, equipped with a set of jigs, and in good repair, is located near the excavations. Water is pumped from a large spring on the Satterfield *lot, No. 270*, a distance of three-quarters of a mile southwest from the washer.

Considerable prospecting has been done on *lot 203*, in the nature of small pits and shafts of slight depth. These show ore, of the same character and quality as that described on *lot 272*. Quartz granules are enclosed, in greater or less quantity, in the ore from most of the openings.

Surface indications for manganese ore are favorable, in places on *lot 267;* but no developments have yet been made on the lot. One small pit was dug some years ago.

THE MORRIS PROPERTY

This property, which includes *lots 333 and 533, 4th district, 3rd section,* Bartow county, has been prospected, to a very limited extent, for manganese ores. A small quantity of ore is reported to have been shipped from *lot 533*.

Lot 332, 4th district, Bartow county, known as the STEPHENS LOT, was prospected, to a limited extent, some years ago, and one carload of manganese ore is said to have been shipped. No recent work has been done.

THE AKIN PROPERTY

Lots 304, 314 and 315, 5th district, 3rd section, Bartow county, owned by the Hon. John W. Akin, of Cartersville, have been worked for manganese ores.

Lot 304, known as the CULVER LOT, is located directly on the wagon-road; and in part it occupies a portion of the west slope of a high and steep quartzite ridge. It is opposite to and across the valley from the Milner-Harris property, described above. The ridge surface is thickly covered with loose fragments of the quartzite. Manganese ores have not been mined on the lot for many years, and the numerous excavations were nearly entirely filled in, from

caving, so that the exact nature of the deposits could not be made out. The openings occur near the base of the ridge.

So far as could be made out, the occurrence and character of the ore on this lot resemble, in all respects, that described on the adjoining property to the west, the Milner-Harris. The remnants of an old log-washer are seen on the lot near the excavations; and it is said, that ores were hauled from other nearby properties and washed on this lot.

Lot 314, known as the STEPHENSON LOT, was being worked at the time of my examination in the fall of 1901. The ore was shipped to the Carnegie Steel Company in Pittsburg, Penn. Much prospecting has been done; but only one excavation is of sufficient size to yield workable quantities of ore. This is a pit, which, at the time of my visit, was worked to the depth of 35 feet, and was at least from 50 to 60 feet wide. The ore consists of fine gravel containing some large concretionary masses, the whole enclosed as pockets and stringers in a yellow, gravelly clay. The following chemical analyses, made by the Tennessee Coal and Iron Company, show the results of the first carloads of ore shipped from *lot 314:* —

	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Manganese	38.800	40.520	34.690	37.850
Silica	11.450	8 420	25.900	21.370
Phosphorus	0.160	0.169	0.108	0.134

Gray specular iron ore is exposed in test-openings made in the southwest corner of the lot.

Lot 315, known as the WHITE LOT, was extensively worked near its center in 1884-'5 by the Dade Coal Company, for manganese ore. It was subsequently worked at different times, under lease to private individuals. A large quantity of the ore has been mined and shipped. A number of open-cuts were worked to a depth of from 30 to 60 feet. The work was of such long standing, and the excavations had caved in to such a degree, that not much satisfactory data on the geology of the deposits could be obtained. The ore was principally of the gravel type, containing large and partially crystalline, concretionary masses, embedded in yellow clay. It is said to have been of excellent grade, averaging high in metallic manganese and very low in phosphorus.

THE SOUTHERN MINING COMPANY'S PROPERTY

The Southern Mining Company owns the following lots of land in the *5th district, 3rd section* of Bartow county, on which manganese ores have been worked: *Nos. 299, 300 and 313.*

The principal developments have been made on *lot 300.* Three open-cuts, averaging 100 feet in length, and worked to a depth of 30 or more feet, were opened by the Dade Coal Company. This company, it is reported, averaged one carload of ore per day from these cuts, for several years. Other smaller excavations have been made in places on the lot, and much ore has been taken from them. The cut in the southeast corner of *lot 300* has its greatest extension on *lot 299.* The residual clay is generally of a red, yellow or some dark color. The ores are distributed largely through the yellow clay, and are of the gravel and larger concretionary-nodular types. It is of the usual quality; but it requires much washing to free it from the adhering clay. A log-washer for cleansing the ores is located on the line between *lots 299 and 300. Lot 300* is known as the BURFORD LOT, and is one of the chief iron-ore producers in the locality. *Lot 313* has been worked to only a limited extent; but it has been fairly well prospected. A few carloads of ore were shipped by the Dade Coal Company. The mode of occurrence and character of the ore are similar to those described on *lot 300.*

Considerable iron ore, both of the brown and gray specular hematite varieties, is somewhat closely associated with the manganese deposits on the three lots. On the adjoining *lot, 312,* are located the famous WILD CAT iron ore mines, which have yielded large supplies of ore.

I was reliably informed, that two borings, put down on the Southern Mining Company's lots with a diamond drill, passed through from 350 to 360 feet of vari-colored clays, before piercing the hard and fresh bed-rock. The clays were principally of the shades, yellow and white, mixed with some sand and gravel. The bed-rock underneath the clays is a conglomerate.

THE T. R. JONES LOT

Lot 190, 4th district, 3rd section, Bartow county, occupies a part of the south slope of the same quartzite peak as the Kennedy lot,

171, which *lot 190*, joins on the south side. Only one opening, of any consequence, from which manganese was mined, is to be found on the lot. This was an open-cut, worked to a depth of 30 feet, with drifts worked from the sides of the cut. The lot was prospected to a limited extent, in several other places; and some ore was found. The work is all of long standing. The ore is of similar character and occurrence as that described on *lot 172*, owned by Laramore, Stephens & Daniel. It is estimated, that probably not less than 400 tons of the ore were mined.

THE DOBBINS PROPERTY

The DOBBINS PROPERTY is located in Bartow county, five miles northeast from the town of Cartersville, and consists of the following lots of land, on which manganese ores occur: —

Lot No.	Acres	District	Section
270	160	5	3
271	"	"	"
24	40	4	"
30	"	"	"
31	"	"	"
42	"	"	"
43	"	"	"

The property was first opened in 1867, and is one of the oldest manganese mining properties in the State. Prior to the leasing of the property by Mr. E. H. Woodward in 1885, it was worked by the Bartow Mining and Manufacturing Company. From 1867 to 1885 inclusive, 5,500 tons of ore are said to have been mined.[1]

In 1886, Mr. Woodward shipped 726 tons of the ore.[2] The principal mining has been done on *lot 271*, and the excavations made on this lot are known as the DOBBINS MINE. The openings have been numerous and large. It is not possible to estimate the exact amount of ore mined on this lot; but it is safe to say, that it has been greater than for any other single lot in the State.

Eight main cuts, averaging from 100 to 150 feet in length, 50 feet wide and from 25 to 30 feet in depth, have been worked. Six

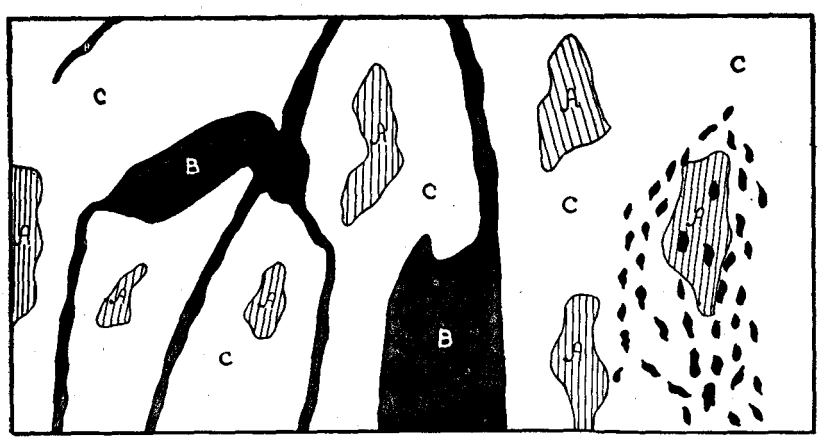
[1] Mineral Resources of the United States, 1885, p. 330.

[2] *Ibid.*, 1886, p. 187.

shafts have been sunk, with the following approximate depths: 50, 80, 100, 106, 110 and 190 feet. Drifts or tunnels were run from all the shafts at different levels, for long distances and in different directions. Similar smaller openings have been dug over all parts of the lot, and manganese ore exposed in all of them.

The ores are mostly massive with smaller quantities of crystalline ore. They occur in the form of pockets and lenticular beds, and as concretionary nodules enclosed in red, yellow, brown and darker-colored clays.

FIG. 8



Section in One of the Openings in the Dobbins Mine, Bartow County, Georgia, Showing the Occurrence of Manganese Ore in the Residual Clays (Modified from Penrose). A. Partially Decayed Rock Fragments and Masses. B. Manganese Ore. C. Residual Clay.
Horizontal and Vertical Scale: 1 inch=10 feet.

The surface clay is usually red in color, and will average less than six feet in depth. The original stratification of the fresh rock is well preserved in the residual clays, in places. In a general way, it conforms to the hill-slope. In many instances, the ore follows in a general way the stratification in the original rock; but it, as frequently, ramifies in all directions, and cuts across the stratification. The position of the ore-bodies in, and their relationship to, the surrounding clays are shown in the accompanying figure. The ore-bodies vary from a few inches to more than five feet in width, and they alternately thin and thicken. A rather

common occurrence of the ore is as nodules closely assembled in the clay, shown in the right-hand side of the figure. The figure further indicates the occurrence of sandstone, or quartzite, and shaly sandstone fragments, measuring, at times, several feet in diameter, in the clays. Seams and small particles, or grains, of the ore are often contained in these fragments.

The fairly coarse quartzite, or sandstone, outcrops as a low reef about 15 feet wide along the crest of the ridge. The outcrops are marked by broken, rocky fragments, which are contrasted with the surrounding covered slopes. A large quantity of ore is to be seen in places along the sides of the old openings. Quantities of wash ore, which would prove profitable, form a considerable proportion of the dumps, abandoned years ago.

Lot 270 is a continuation of *lot 271* along the steeper slope of the same quartzite ridge. It has been prospected to some extent; but only a small amount of the ore has been mined. The principal work includes one small open-cut and a tunnel. The character and occurrence of the ore are the same as those described under *lot 271*.

The remaining lots of the Dobbins property, *Nos. 24, 30, 31, 42 and 43, 4th district,* occupy a steeply sloping quartzite ridge, across the valley and to the east of *lots 270 and 271*. No work has been done on these lots; but they have been prospected, to a limited extent, with favorable indications for manganese.

THE CHEROKEE OCHER AND BARYTES COMPANY'S PROPERTY.

This property, known as the Parrott Spring property, includes *lots 406 and 459, 4th district, 3rd section,* Bartow county, and is located approximately one mile east of Cartersville. An ocher-mill is operated on the property, and deposits of the mineral are worked near by. Some years ago, manganese ores were mined from open-cuts, shafts and tunnels. Only the ocher is worked at present. At the time of my examination, the openings had caved in to such an extent, as to make the exact nature of the ore-bodies difficult to determine. The manganese was apparently intimately associated with limonite; and it probably averaged high in metallic iron.

THE ROWAN PROPERTY

The ROWAN PROPERTY includes *lots 191, 242, 243, 263 and 264,*

4th district, Bartow county, on which manganese occurs. No prospecting has been done on *lots 191, 242 and 243;* but manganese occurs, in places, as loose fragments over the surface. Several small pits have been dug on *lots 244 and 263,* exposing some ore. *Lot 264* has been worked to a limited extent, and three carloads of ore are reported to have been shipped. The excavations include two open-cuts and several tunnels. The former were worked to an approximate depth of 25 feet. Some manganiferous quartzite breccia occurs.

THE HOLLAND LOT

Manganese is reported to have been mined to some extent on *lot 904, 4th district, 3rd section,* Bartow county. One tunnel was driven into the southeast slope of a steep quartzite ridge, near its base, several years ago, from which manganese is said to have been worked. The tunnel had fallen in, at the time of my examination, and there were no indications of manganese visible either at the opening or on the dumps. A number of open-cuts have been made on both sides of the tunnel, from which brown iron ore was mined. One of the largest cuts, worked for iron ore in this section, is less than 25 paces from the Holland tunnel, in the southwest corner of *lot 903.* From all indications, *lot 904* is more valuable as an iron property than for manganese.

Lot 762, 4th district, 3rd section, Bartow county, owned by Mr. J. C. Leonard and others, of Emerson, Georgia, shows surface indications of both manganese and ocher.

CHAPTER IV

THE MANGANESE DEPOSITS OF THE PALEOZOIC AREA (*Continued*)

The Cave Spring District

LOCATION OF THE CAVE SPRING DISTRICT

The Cave Spring district occupies the southwest part of Floyd and the northwest corner of Polk counties, as is shown on map.[1] The manganese deposits commence between four and five miles south of the town of Cave Spring, in Polk county, and continue northeast from the town for a distance of seven or eight miles in Floyd county. The town of Cave Spring, which is the largest and the principal shipping point in the district, is located in the extreme southwest corner of Floyd county, five and a half miles east of the Alabama-Georgia State-line, one and three-quarter miles north of the Polk county-line, fifteen miles southwest of Rome, and nine miles northwest of Cedartown. The manganese area, as here defined, is about 13 miles long, in an approximately northeast-southwest direction, and is between four and five miles in width. The region thus limited represents that part of the State, in which manganese ores occur at varying intervals; and the ores may or may not exist in paying quantities in any one place. The ores, in other words, are by no means continuous over the entire limits of the area thus defined.

The Cave Spring region takes first rank after the Cartersville district, in the production of manganese ores in the State. In fact, the entire production of these ores in Georgia has been from the

[1] See Fig. 9.

Cartersville and Cave Spring districts. The largest deposits of manganese, exploited in the Cave Spring district, are those of the Georgia Manganese and Mining Company. Some of the deposits in this district were opened, to some extent, during the early history of manganese mining in the State; but the production does not date back farther than 1883.

THE TOPOGRAPHY OF THE CAVE SPRING DISTRICT

The area is fairly well watered by small streams, which drain principally into Big Cedar creek, the largest stream in the district, which, in turn, drains into the Coosa river from the south. The topography of the region is strikingly shown to be dependent on the geologic structure, and on the character of the different rocks. The rocks no longer occupy nearly horizontal positions; but, instead, they are broken by numerous faults, of the ordinary Appalachian type, which extend in an approximate north-south direction. The strata dip somewhat steeply to the southeast, and the fault blocks overlap each other in a striking manner. These faults have brought the underlying shales to the surface in close contact with the overlying Knox dolomite. Valleys have been etched out along the soft shales, and have penetrated, to some extent, the harder and more resistant Knox dolomite. Where the narrow belts of shale are exposed, the position of the faults is easily located; but, in many cases, their southward extension is difficult to determine; as they penetrate the Knox dolomite and expose the same kind of rock on the two sides of the fault line. This is further obscured by the rock-surface being covered by a heavy mantle of residual cherty clay. This feature of the faults is typically shown in the area to the south of Six Mile station and Silver creek, six miles south of Rome, and from eight to ten miles northeast of Cave Spring.

The region to the east of a line passing south through the town of Cave Spring is largely underlain by the Knox dolomite. This formation contains a large amount of chert, which, upon weathering, remains upon the surface, admixed with the red clay. Surface erosion, in this part of the area, is relatively slower than in other adjacent parts underlain by softer and less resistant rock. Its surface, which is hilly, is several hundred feet above the adjacent low

lands of softer rock. It forms a broad plateau, the general altitude of which is under 1,000 feet, though areas, over its surface here and there, will average one thousand and more feet above mean tide-level. In the extreme southwest corner of this region, the northeast extremity of the hard and resistant Weisner quartzite is exposed as a high and distinct ridge, known as Indian mountain, which lies almost entirely in Alabama.

Over those parts of the area, where faults have been traced, as in the Six Mile-Silver Creek region, and in the region to the north and south of Cave Spring, the surface is much broken by numerous steep-sided parallel ridges, somewhat irregular in form, and extending nearly north and south.

When this region is examined in detail, with respect to erosion, and in connection with adjacent ones, distinct evidence of several periods of base-leveling is found to exist. Indian mountain is regarded as representing an unreduced residual of extremely hard rock, which stood somewhat above the general level of the first plain of erosion, when the land surface occupied a lower level than at present, with respect to the sea, and was reduced by erosion to nearly the level of the sea. The levels of this plain are best preserved, to the north and east in the area of hard crystalline rocks of the Piedmont plateau, and to the northwest in the higher levels of the Cumberland plateau. The second plain is marked by the general level of the Knox dolomite plateau to the north and south of the Etowah river; and it will average less than 1,000 feet in elevation. Still a third level, representing the present valley bottoms of the major streams, is recognized in the soft shales of the Coosa Valley region, which stands much below the level of the Knox dolomite plateau.

STRATIGRAPHY OF THE CAVE SPRING DISTRICT

The rocks of the Cave Spring district, shown on the accompanying map,[1] range in age from Lower Cambrian to Lower Silurian. They include quartzite, shale and limestone. The succession of formations in this district is much the same as that described above, in the Cartersville district. The same formations are represented

[1] See Fig. 9.

in the two districts, with only slight variations in general character and thickness indicated. Named in ascending order, the formations of the Cave Spring area are : —

CAMBRIAN	1	The Weisner quartzite (Chilhowee sandstone, of Safford)
	2	The Beaver limestone
	3	The Rome shale and sandstone
	4	The Conasauga shale (Oostanaula shale, o Spencer)
LOWER SILURIAN	5	The Knox dolomite (cherty maganesian limestone)

These formations have been described in some detail under the stratigraphy of the Cartersville district, and need not be repeated here. Their distribution is shown on map, Fig. 9.

The Knox dolomite is much the most extensive formation and is the prevailing rock of the district. The percentage of chert is much greater, and the cherty masses and fragments are generally larger, in the Cave Spring region than elsewhere. In places, the limestone appears to be very largely replaced by layers of massive chert. The dolomite surface is usually thickly strewn with larger fragments and masses of the chert, and the deep-red clay, derived from the dolomite decay, is very largely admixed with the chert, of varying size fragments and in all stages of decay.

STRUCTURE OF THE CAVE SPRING DISTRICT

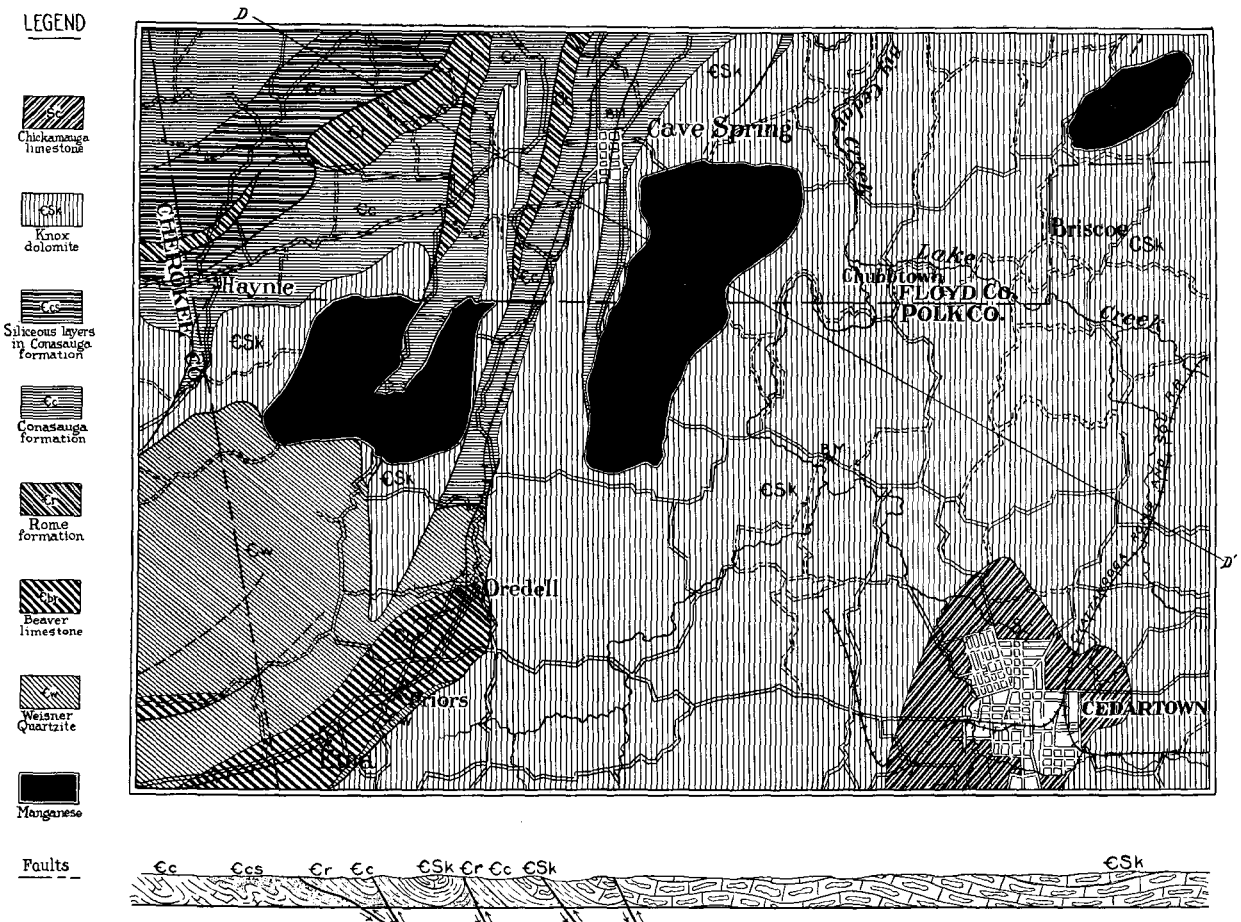
The rocks of the Cave Spring district may be said to be separated from those to the north and northwest by two major lines of breakage; namely, the Rome and the Coosa major thrust-faults. These faults are of the same general type as the Cartersville fault, described on page 46. The Coosa fault-plane dips eastward at a low angle, rarely more than fifteen degrees. The plane of the Rome fault has a steeper eastward dip, owing to subsequent folding, though, prior to the folding, the dip was probably as low as that of the Coosa fault-plane. The intersection of the fault-planes with the surface of the earth is a very irregular one, marked by a number of heavy curves and deep indentations. This irregularity is particularly characteristic of the Rome fault, which is explained by the fault-plane

having been folded with underlying and overlying rocks, after the fracturing occurred, and by partial subsequent erosion of the folds. In this fault, the Cambrian and the overlying rocks to the southeast were thrust westward upon the surface of the Floyd shales (Carboniferous).

In the Cave Spring region proper, the area is intersected by a large number of minor thrust-faults, of a type entirely distinct from those already described. The minor faults extend nearly north and south, making angles of thirty to forty degrees with the major structures, whose axes trend northeast-southwest. The faults intersect the Knox dolomite and the underlying Conasauga shales, exposing at the surface the soft shales in long narrow north-south strips, forming narrow valleys among the dolomite hills. As a result of this faulting, the strata are broken into numerous long narrow strips or blocks, overlapping each other and dipping steeply toward the east. Minor faults, of this type, are numerous, and are typically developed in the Six Mile-Silver Creek region to the south of Rome, and in the area to the west of Cave Spring. Wherever the underlying shales are brought to the surface, the faults are readily traced; but they probably extend further southward into the Knox dolomite plateau, the surface of which is covered with a heavy mantle of loose decay; and the rocks on the two sides of the fracture-line are the same. This makes it difficult to locate the faults, so extended. The minor faults, unlike the major thrust-faults, are always observed to have a steep inclination, generally a few degrees more or less than 40° with the horizon. The Knox dolomite formation did not entirely escape folding; but, from its more massive character, it resisted the sharp folding which is observed in the rocks occurring to the northwest of this area.

The topography of the Cave Spring district is of the ridge-valley type. The ridges rise in elevations from 100 to 250 feet above the adjacent valleys. The ridge slopes are rather steep, with the intervening valleys correspondingly deep and narrow. The ridges are usually much dissected on the tops and slopes from transverse erosion.

Fig. 9



Geological Map of the Cave Spring District, Georgia, Showing the Distribution of the Manganese Deposits, by **Thomas L. Watson, Based on the Rome Folio, U. S. Geological Survey.**

CHARACTER OF THE RESIDUAL DECAY IN THE CAVE SPRING DISTRICT

As has already been stated, and as may be seen from the accompanying map,[1] the principal underlying surface rock in this area is the Knox dolomite. It is further shown below, that the manganese ores are associated in this area only with the residual clays derived from the decay of the Knox dolomite formation. Some have expressed, that at least a part of the manganese has been derived from the chert, which replaces very largely, at times, the limestone. From the standpoint of the ores, then, it is only necessary to deal with the character of the decay derived from the Knox dolomite.

The character of the residual material, which everywhere covers the rock to some depth in the Cave Spring district, is quite similar to that occurring over areas to the north underlain by the Knox dolomite. The clay containing the ore is usually of a deep-red, chocolate or other brown color; though lighter tints sometimes occur. The clay is soft and plastic, when wet, and is generally associated with much siliceous material, the percentage of which varies greatly from place to place. The depth of this residual mantle varies considerably, being greater in the valleys and near the lower slopes of the ridges, and thinner toward the ridge tops. In a few places, moderately fresh cherty limestone is exposed as broken reefs on the ridge tops; in others, where excavations have been made, the underlying rock is encountered at depths varying from 15 to 30 feet; and, in others still, bed-rock on the hill-tops was not reached at depths of from 50 to 60 feet. Exposures of the fresh rock are rare.

Massive cherty layers, or beds, and nodules are of more frequent occurrence in places through the magnesian limestone than in other areas of the Knox formation in northwest Georgia. Here, the chert attains considerable thickness, and almost entirely replaces the limestone, in places. On weathering, the soluble carbonates are removed in solution, leaving a deep-red siliceous clay, in which the proportion of chert is variable. In those areas where the chert composed the bulk of the rock, the residual clay consists principally of

[1] See Fig. 9.

chert fragments, which vary greatly in size, from a few inches to several feet in diameter, and are in all stages of decay, from nearly fresh hard, flinty rock to a porous, siliceous, earthy mass. Usually the chert is a white or gray rock, sometimes brown, rarely black, and frequently encrusted with a film of the black oxide of manganese.

The relation of the chert and limestone is well illustrated along the ridges to the southeast of the town of Cave Spring. The rocks here dip to the southeast, with the limestone forming the lower parts of the hills and the chert, the upper parts. Groups of very large chert masses, measuring many feet across and standing several feet above the surface, were observed in a number of places along the roadside to the north of the town.

MANGANIFEROUS CHERT BRECCIA

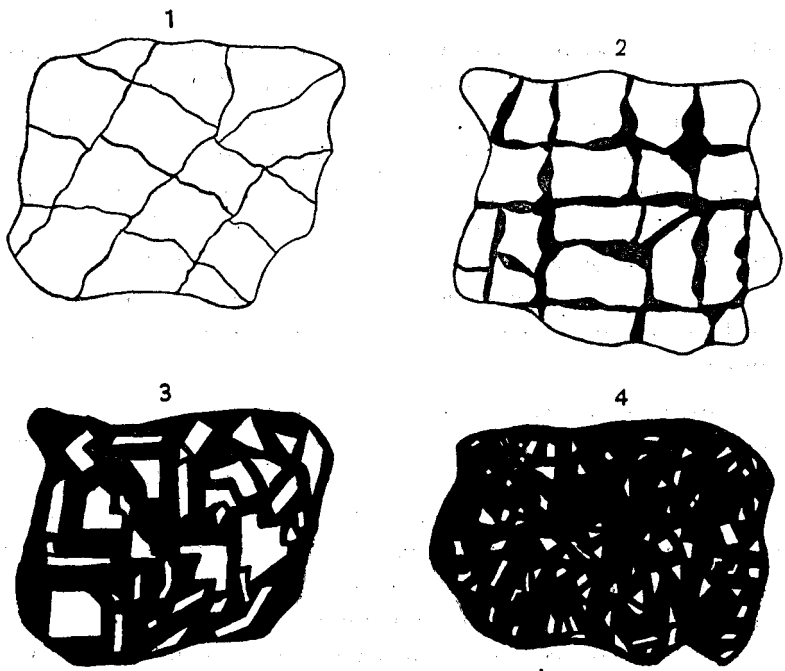
The ore-bodies of the Cave Spring district are generally more or less closely associated with the cherty masses. This association of chert and ore has resulted in the formation of a considerable quantity of breccia of angular chert fragments, cemented in a black manganiferous matrix. This seems to have originated, in most cases, by the infiltration of surface-waters containing manganese in solution. At times, it may have been formed by the chert becoming embedded in a dark manganiferous clay which subsequently hardened. That the first process accounts for most of the breccia is proved by the fact that the brecciated cherty mass occurs beneath the clay covering, and not on top. This occurrence is excellently illustrated in some of the excavations on the top of the ridge, above the valley of Cedar creek; and again, at the openings on Reynold's mountain, eight miles to the northeast of Cave Spring, where the breccia is made up in part of the partially decayed, manganiferous, cherty limestone exposed in the bottom of the pits.

MANGANIFEROUS STAINED CHERT

Where the chert is admixed with the manganese-bearing clay, it is frequently more or less stained with manganese.

This may occur as thin films, or layers, of the manganese oxide, coating the loose chert fragments, or as stringers or veinlets per-

FIG. 10



Figures Illustrating the Formation of Manganese-breccia Ore in the Lindale and Cave Spring Deposits, Floyd County, Georgia. Manganese Oxide is represented by Black Lines and Areas. The White Areas represent Fragments of Chert and Sandstone. Attention Is Directed to the Increase in the Proportion of Ore to Rock in Passing from 1 to 4.

meating the cracks in the chert. The proportion of the staining to the chert is quite variable. In some cases, it amounts to a mere film of knife-edge thickness; in others, the cracks in the chert are filled with quite an appreciable thickness of the ore. This has resulted from the free percolation of manganese-bearing waters through the loose, cherty clay.

It sometimes happens, that the part not impregnated has been either partially or entirely removed by subsequent decay, leaving a mass of siliceous manganese ore of various forms, stalactitic and botryoidal forms being common.

MODE OF OCCURRENCE OF THE MANGANESE ORES

The mode of occurrence of the manganese ores in the Cave Spring district is closely similar to that of the Cartersville district, described on pages 47-48 of this report. The ores differ from the Cartersville ores, principally in that they are frequently closely associated in their occurrence with chert. They are embedded in a red or chocolate-colored clay, resulting from the decay of the cherty limestone. In no case, were the ores found in place in the fresh rock; though it is possible that some of the occurrences of the ore existed as such in the original rock, and have undergone but little subsequent change.

The manganese ores occur in the residual cherty clay, as disseminated grains, or pellets, and nodules; pockets, or lenticular layers; and stringers. In some cases, the ore-bodies follow the general direction of the bedding of the strata; and, in others, they cut across the bedding at all angles. The ore is very irregularly distributed through the residual material, being entirely wanting in some places, and occurring at short intervals over considerable areas in others. It has been observed penetrating and filling the cracks in the partially decayed rock below, in all directions, giving much the appearance of brecciated masses. Figures 11, 12, 13, 14 and 15 illustrate the usual occurrence of the manganese ores in this area.

ASSOCIATED ORE DEPOSITS

Limonite beds are frequently found, closely associated with the manganese deposits. The beds of brown iron ore are of greater extent, and are more constant than those of manganese. The iron has a stronger tendency to a bedded form, and a less tendency to a nodular form. The region around Cave Spring and Cedartown is perhaps the largest brown-ore-producing area in the State. The deposits have been extensively worked, and considerable mining is being done at present. A few scattered deposits of bauxite occur; but this mineral is less closely associated with the manganese than are the beds of iron ore.

THE KINDS OF MANGANESE ORE OCCURRING IN THE CAVE SPRING DISTRICT

The ores found and worked comprise only the oxides of the metal. The principal oxides are psilomelane and pyrolusite. These usually occur mixed in varying proportions in the same mass or nodule, and are difficult of complete separation. Admixed with these two oxides, probably occur varying smaller percentages of several of the other oxides, especially braunite. Scattered through the clay, are more or less extensive accumulations of black earthy manganese powder, which may be composed of mixtures of the various oxides. Besides these ores, valuable deposits of admixed iron and manganese oxides occur.

The following chemical analysis of the purer manganese ore from the Cave Spring area will serve to show the general character of the ores. The specimens were collected from the mine of Major J. M. Couper, south of Cave Spring, and were analyzed by Mr. J. Blodget Britton, of Philadelphia: —[1]

	Per Cent.
Metallic Manganese	53.440
Ferric Oxide	2.830
Baryta	8.620
Water	1.560
Silica	7.790
Alumina	1.520
Lime	0.080
Phosphoric oxide	0.147
Oxygen with Manganese, Undet., Etc.	24.013
Total	100.000

THE CHEMICAL COMPOSITION OF THE CAVE SPRING ORES

The following chemical analyses of carload lots of ore, from various mines in the Cave Spring area, will show the commercial value of these ores: —

	I	II	III	IV	V	VI
Manganese	46.749	42.685	42.938	42.578	42.307	45.189
Iron	1.746	1.729	5.240	1.500	2.400	7.840
Silica	13.050	10.000	8.009	11.950	10.390	7.602
Phosphorus	0.059	———	———	0.089	0.072	0.035

[1] The Paleozoic Group, Geol. Survey of Georgia, 1893, by J. W. Spencer, p. 193.

I. Shipment of a carload of thirty-two hundred pounds of the ore, December 1st, 1889, from Major J. M. Couper's mine. The Paleozoic Group, Geol. Survey of Georgia, 1893, by J. W. Spencer, p. 194.

II, III, IV and V. Shipments from residuary surface ores, made October, 1890. The Paleozoic Group of Georgia, Geol. Survey of Georgia, 1893, by J. W. Spencer, p. 194.

VI. Shipment of ore to Carnegie & Company, from Mr. Asbury's property, northeast of Cave Spring. The Paleozoic Group, Geol. Survey of Georgia, 1893, by J. W. Spencer, p. 194.

A chemical analysis of specimens of the more crystalline, but dark-colored, dolomite, from Cave Spring, gave J. M. McCandless, Atlanta, Ga., the following figures: —[1]

	Per Cent.
Lime, $CaCO_3$	53.44
Magnesia, $MgCO_3$	41.15
Alumina, Al_2O_3 } Iron Sesqui-oxide, Fe_2O_3	1.50
Silica, SiO_2	3.75
Total	99.84

Analyses of soils, derived from the decay of the Knox dolomite in Polk, Floyd and Bartow counties, gave J. M. Candless, of Atlanta, Ga., the following figures: —[2]

	I	II	III	IV	V
Silica, SiO_2	64.500	66.619	82.018	79.326	79.039
Alumina, Al_2O_3	12.680	12.340	5.352	6.821	4.794
Iron Sesqui-oxide, Fe_2O_3	10.356	10.213	2.962	3.212	3.231
Magnesia, MgO	1.021	0.876	0.092	0.732	1.213
Lime, CaO	3.111	3.040	1.240	1.625	2.964
Potash, K_2O	0.671	0.462	0.262	0.156	0.436
Soda, Na_2O	1.101	0.112	0.314	0.210	0.287
Sulphur Trioxide, SO_3	0.420	0.238	0.092	0.096	0.183
Phosphorus Pentoxide, P_2O_5	0.063	0.042	0.015	0.034	0.240
Water, H_2O	4.310	3.600	3.115	2.312	2.648
Organic Matter	1.204	2.104	3.675	5.111	4.113
Undetermined Loss, Etc.	0.563	0.354	0.863	0.365	0.872
Total	100.000	100.000	100.000	100.000	100.020

[1] Paleozoic Group of Georgia, Geol. Survey of Georgia, 1893, by J. W. Spencer, p. 265.

d., pp 339

I. A deep-red soil in an ore-bank, four miles southwest of Kingston. Composed of rounded grains of quartz, from .01 to .02 of an inch in diameter, surrounded by a large proportion of clay.

II. A deep-red soil from the surface of an ore-bank, southwest of Cedartown. Composed of rounded grains of quartz .01 of an inch in diameter, in much clayey matter.

III. Light-gray siliceous soil from near Seney. Composed of particles of semi-glassy earth, and some rounded quartz grains, from .004 to .005 of an inch in diameter. It is a very siliceous soil with a small amount of iron.

IV. Gray, siliceous soil, two miles south of Cedar creek in the northern part of Bartow county. Composed of a glassy matrix, the particles of which are less than .002 of an inch in diameter. In it there are rounded quartz grains .004 of an inch in diameter.

V. A drab-gray, siliceous soil, composed of rounded quartz grains, .0125 of an inch in diameter, loosely embedded in a small amount of earthy matter. From Mr. Osburne Shaw's farm, three miles north of Wooley's Ferry.

VI. A dark-gray soil near Wooley's ferry. Composed of crystalline particles in an opaque matrix consisting of very small grains. It also contains some rounded particles of quartz, .008 of an inch in diameter.

DESCRIPTION OF INDIVIDUAL PROPERTIES IN THE CAVE SPRING DISTRICT

The various properties, on which manganese ores occur in the Cave Spring district, are distributed over contiguous portions of Polk and Floyd counties. The properties can best be described separately by counties. The manganese ores are limited to the northwest part of Polk and the adjacent southwest part of Floyd county, near the Georgia-Alabama State-line, and along the line separating Polk and Floyd counties in Georgia.

The Manganese Properties of Polk County in the Cave Spring District

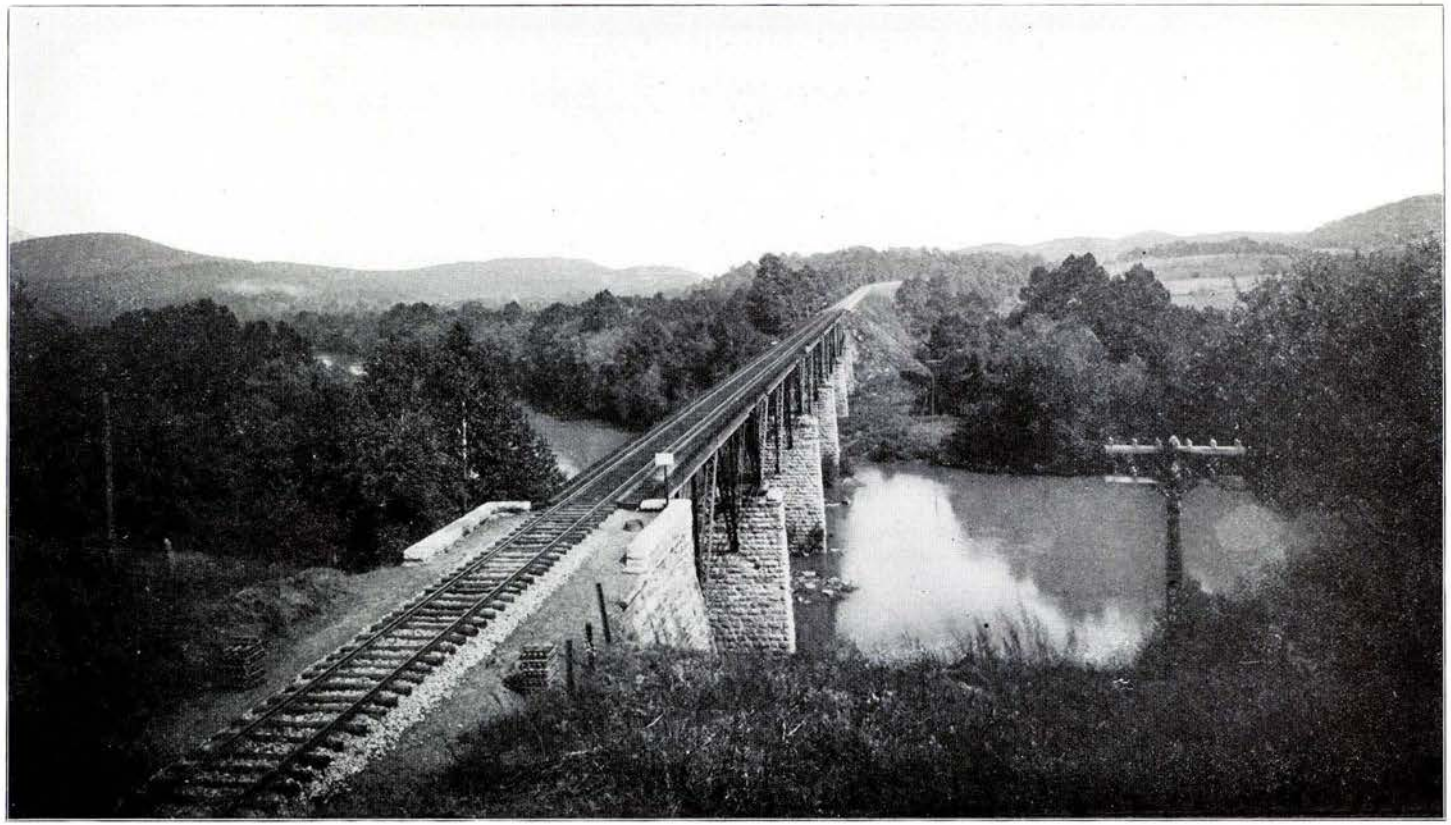
THE LOPEZ PROPERTY

The following lots of land, on which manganese ores occur and have been worked, are owned by Mr. D. H. Lopez of Buford, South Carolina.

Lot No.	Acres	District	Section	County	Remarks
1216	40	3	4	Polk	Old Workings.
1217	"	"	"	"	" "
1232	"	"	"	"	
1288	"	"	"	"	
1289	"	"	"	"	
351	"	2	"	"	
297	"	"	"	"	
926	"	3	"	Floyd	
927	"	"	"	"	
998	"	"	"	"	

Lots 926 and 927, known as the Hancock Property, and *lot 998* in Floyd county, owned by Mr. Lopez, are described under the Floyd county properties on page 122 of this report.

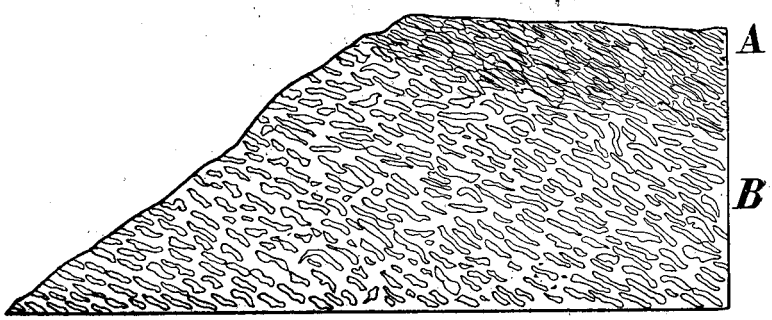
Lots 1216 and 1217. — These lots join each other in an east-west direction, and form a part of the original William Daugherty tract, two miles south of Cave Spring. Less than half-a-dozen openings, extending over an area of several acres, through which the line between the two lots passes, were worked some years ago, and some of the ore was shipped. The greatest depth reached in working the pits did not exceed 20 or 25 feet. The openings are made on the slope of a chain of low, rounded, broken hills, the highest of which will average from 75 to 125 feet above the neighboring valley bottoms. The surface of the hills is covered with loose fragments of chert, of various sizes and in all stages of decay. No continuous exposures of rock, in place, occur at the openings; but, about half-a-mile to the north, the cherty rock is exposed on the slope of a ridge, which trends northeast-southwest. The chert dips



A VIEW SHOWING THE ETOWAH RIVER AT THE WESTERN & ATLANTIC RAILROAD BRIDGE, NEAR CARTERSVILLE, GEORGIA, AND THE ADJACENT RIDGES.

to the eastward at about 30°. At this point, the chert shows an irregular decomposed surface impregnated, in places, with iron oxide, less often, with manganese, which intersects the chert in a network of layers as much as half-an-inch in thickness. Figure 8 shows the relation of the fresh and decayed chert on this ridge.

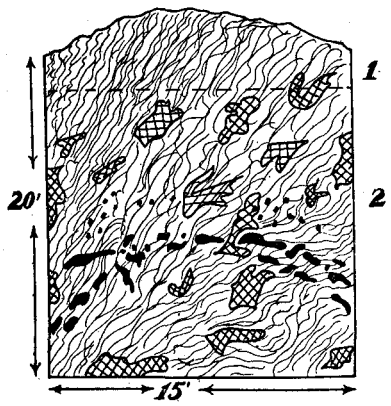
FIG 11



Section near the William Daugherty (Lopez) Tract, Showing the Surface Decay of the Manganese-bearing Chert Bed (After Penrose). A. Decayed Chert. B. Undecayed Chert.
Horizontal Scale: 1 inch=500 feet. Vertical Scale: 1 inch=250 feet.

The pits expose an average thickness of three feet of deep-red surface clay, which is underlain by lighter red, white and yellow-mottled clays containing many fragments of chert in various stages of decay. The ores are generally distributed through the underlying mottled clays, in the form of nodules, which vary from one inch to one foot and more in diameter. These concretions thickly stud the clay in places, and are very much scattered and separated at other places. Some lenticular beds of massive ore, not exceeding two feet in thickness and of limited lateral extent, were observed in several places. Beds of limonite occur near by; and, in some of the manganese ore pits, the two ores are associated. The bedding-planes of the original rock, which are partially preserved in the residual clays, are cut indiscriminately by the ores. Considerable steel-blue nodular ore was still to be seen along the faces of some of the pits. This was apparently remarkably free from silica. Figure 9, which represents a vertical section in one of the pits on *lot 1216,* shows the mode of occurrence of the ores in the clay.

FIG. 12



Section of a Pit on the Lopez Lot, No. 1216, 3rd District, Polk County, Georgia, Showing the Occurrence of Manganese Ore in the Clays. Cross-hatched Areas Indicate Fragments of Chert. Black Areas and Dots Indicate Manganese Ore. 1. Deep-red Clay. 2. Red, Mottled Clay Filled with Chert Fragments.

Penrose states, that the ore is sometimes found in place on this tract.[1] The writer did not see any of the ore in place in the chert.

A small log washer without jigs was located at the base of the ridge slope near the old openings, where the ore from the two lots was cleansed and prepared for shipping.

Lots 1232 and 1289. — *Lots 1232 and 1289* are the adjoining lots on the south to *lot 1217*, and are known as the HENDRIX TRACT.

Several small openings occur, which were worked many years ago, and from which some ore was reported to have been shipped. No manganese mining has been done for ten years. An excellent grade of iron ore from an extensive deposit of limonite was being worked at the time of my examination in July, 1902. Several thousand tons of the iron ore have been shipped from *lot 1232*. This is distinctly an iron property.

Lot 1288. — A goodly number of shallow openings were worked on this lot some years ago, and a large amount of manganese ore is said to have been shipped. The deepest pit will not exceed 15 feet in depth. The openings are located near the middle slope of a

[1] Geological Survey of Arkansas, Ann. Report for 1890, p. 427.

steeply sloping cherty limestone ridge. At the time of my examination in July, 1902, very little was to be seen; as the pits had badly caved in, and all ore had been well sorted from the dumps and shipped. So far as could be determined, the ore occurrence on this lot is quite similar to that described above on *lots 1216 and 1217*. The visible ore was of the nodular type, free from chert fragments; but, as a rule, it passes into limonite. Some recent prospecting has been done, and about 50 tons of brown iron ore have been shipped.

Lots 297 and 351, 2nd District. — These two lots are known as the DEMPSEY TRACT. They are about one mile south of *lots 1288 and 1289*, described above. Considerable prospecting has been done for manganese with favorable results. Some "float" ore is scattered over the surface. A good grade of limonite occurs on both lots.

THE SHAW PROPERTY

Lots 110, 111, 179, 183 and 184, 16th district, contain *slight* surface indications of manganese, in places, in the nature of "float" ore. Some limonite ore was mined on *lot 183* during the year 1901. Similar ore is reported on the other lots.

THE YOUNGBLOOD PROPERTY

Lot 105, 16th district, has been tested in several places for both manganese and limonite, with favorable results in each case. No ore has been shipped.

THE SCARBAUGH LOT

Lot 180, 16th district, is located on the north slope of a cherty dolomite ridge, about three miles southwest of Cave Spring. The lot was first tested for manganese about 15 years ago, when one carload of ore is said to have been shipped. It was worked again in 1901, and two carloads of ore were shipped.

The principal openings include two cuts, several paces from each other, located from 75 to 100 feet above the valley-bottom, and on the north slope of the ridge. The cuts will average less than 15 feet in depth, and are in red and light-yellow clay, which contains many fragments of chert, in various stages of decay. The ore is

usually embedded in the clay, in the form of irregular bands and stringers, which, in most cases, are in a vertical position; but, at times, they conform in a general way to the slope of the ridge. Some nests of nodular ore are found. The manganese is generally in the form of nodules and chert breccia. The breccia ore seems to predominate. Several test-pits have been dug over other parts of the lot, all of which showed more or less ore. The ore mined was not washed before shipping; as no water-supply is near at hand.

THE LEAK, WRIGHT AND PETERSON PROPERTY

This property includes *lot 109, 16th district,* and *lots 144, 147 and 214, 17th district,* adjoining the Shaw property on the south. *Lot 109, 16th district,* adjoins the Scarbaugh lot on the east; and it occupies a part of the north slope of the same ridge. Several small test-pits have been dug on the lot, near the line of *lot 180,* in the deep-red cherty clay, which show a small amount of a porous and spongy nodular manganese ore.

Lot 144, 17th district, has been similarly tested, and a little ore is reported to have been shipped.

Lots 147 and 214, 17th district, were known as the WATTS PROPERTY. The former *lot* (*147*) was worked somewhat extensively some 20 years ago; and several hundred tons of manganese ore are reported to have been shipped. The manganese mining on this lot is reported to have been the first done in the county; and the ore is said to have sold at a high figure. The openings are now all filled in, and only a slightly irregular surface exists, with no indications of ore. The excavations, mostly in the nature of tunnels, were located from 40 to 50 feet above the valley-bottom, on a slight spur composed of white and light-yellow colored cherty clays. One shaft has recently been sunk to a slight depth near the old openings, but without indication of ore. Surface indications of both manganese and brown iron ore are favorable on *lot 214.* The indications are more favorable for iron, however, than for manganese. No testing has been done.

THE PETERSON LOT

Lot 143, 17th district, corners with *lot 147* of the Leak, Wright and Peterson property, on the northeast. Mining has been confined

to limonite, although good surface indications of manganese occur in places over the lot. Several small pits, from eight to ten feet deep, are dug on the east slope of a high and steep chert-covered ridge, from which some manganese has been removed. The pits expose a white and light-yellow cherty clay, containing some nodules of manganese. Most of the manganese is in the form of a manganiferous-chert breccia. Half-way up the ridge-slope, about 100 feet or more, a pit exposes brown iron ore close to one of the manganese openings.

MRS. L. B. SHAW'S PROPERTY

Mrs. L. B. Shaw's property, which includes *lots 71, 72, 73 and 74, 17th district,* adjoins the Peterson lot *(143)* on the northeast. *Lots 71 and 72* were prospected for manganese many years ago, on the line between them, with favorable results. Slight surface indications appear on *lots 73 and 74.* No work has been done on any of the Shaw lots.

THE PRIOR PROPERTY

Lot 16, 17th district, owned by Mr. J. M. Prior, and *lot 16, 2nd district,* owned by Mr. John T. Prior, show some manganese in several small test-pits. The openings are made on the top of a moderately high ridge, half-a-mile southeast of Prior's station, in a deep-red clay. It is a porous and spongy siliceous manganese ore, replaced at a slight-depth by brown iron ore. The little prospecting done would indicate that the manganese is limited to the surface red clay.

THE SUTHERLIN PROPERTY

The Sutherlin property, which includes *lot 1296, 3rd district, lot 36, 16th district, and lot 1, 17th district,* the three adjoining each other, are within one mile of the north line of Polk county, and about three miles southwest of Cave Spring. The lots occupy the east slope and summit of a much dissected cherty limestone ridge, which has an elevation of several hundred feet above the valley-bottom in its highest parts. A number of openings were made on this slope, near the top of the ridge, some years ago. The work was

principally in the form of tunnels, which have fallen in to such an extent as to obscure the exact relations and nature of the ore deposits. So far as could be determined, the indication on these lots were better for iron ore than for manganese. In fact, only a little manganese was seen. In places the surface is covered with fragments of iron ore, some of which is manganiferous iron ore. Several carloads of the iron ore have been shipped from *lot 1*.

THE MILLICAN PROPERTY

The Millican property, *lot 2, 17th district,* adjoins the Sutherlin property on the south; and it occupies a part of the east slope and summit of the same ridge. One small test-pit has been dug, showing some indications of manganese. Surface indications of limonite appear on this lot on top of the ridge.

THE HAMPTON PROPERTY

The Hampton property, *lots 148 and 214, 2nd district,* occupy the summit and east slope of a steep cherty limestone ridge, which rises between 200 and 300 feet above the adjacent valley-bottom. The excavations, from which manganese was mined, are on the top of the ridge, and are among the most extensive in Polk county. The work was done about 20 years ago; hence the cuts were fallen in, to such an extent, as to render the exact nature of the deposits difficult to determine. A large number of openings were made, extending over an area of several acres, with three principal cuts of very large dimensions. The excavations are in a dark-red to chocolate-colored clay, which exposes, in the bottoms of the larger cuts, large bouldery masses of chert, impregnated and coated with the manganese ore. The chert masses represent undecayed portions of the original rock, which have resisted decay, and now extend from the surface downward through the residual clay to the fresh rock beneath. The masses are much fractured and broken in places, and the fragments are usually re-cemented by a matrix of the oxides of manganese and iron. The greatest depth attained in working did not exceed 25 or 30 feet. Much nodular and gravel ore was distributed through the cherty clay as nests, irregular stringers and

small pockets. Present indications point to the bulk of the ore having been intimately associated with the large quantity of chert as breccia ore. Considerable quantity of the breccia ore is scattered over the surface, and piled about the openings. This was discarded on account of there being no available means at that time for separating the ore from the chert. Much of this can be jigged, and the ore made marketable.

The ore was hauled a distance of one mile from the excavations and washed ready for shipping. It is reported, that a larger quantity of manganese ore was mined and shipped from the Hampton lots, than from any other single property in the county at that time.

THE WHARTON ESTATE

The Wharton estate, which includes *lots 146, 212, 214, 215, 218, 221 and 275, 17th district,* is about five miles southwest of Cave Spring, and within one mile of the Alabama-Georgia State-line. Surface indications, in the nature of manganese "float" ore, appear in places, over these lots. No prospecting has been done. Limonite occurs on some of the lots, and has been worked on some of the adjoining lots.

About two miles west of Hematite siding on the Southern Railway, manganese and manganiferous iron ores occur in the narrow Knox dolomite basin to the west of Cave Spring. Some of this ore occurs on Mr. Simmons' property, and also on some of the adjoining properties. This narrow basin of Knox dolomite is only a few miles in length, and is disconnected from the Cave Spring area by the Cambrian (Conasauga) shales, shown on map, Fig. 9. The ore is variable in character, changing from a manganiferous iron to a ferruginous manganese ore. Only a few carloads of the ore have been shipped.

THE MANGANESE PROPERTIES OF FLOYD COUNTY IN THE CAVE SPRING DISTRICT.

The Manganese Deposits on Reynold's Mountain.

Reynolds mountain is the name given to one of the larger numerous cherty limestone ridges, occurring from six to eight miles east of the town of Cave Spring, and eleven miles south of Rome. The

ridge runs, in a general direction, north-northeast, and rises to an elevation of from 150 to 250 feet above the surrounding drainage. Its crest-line is a very irregular one; and the ridge has been much dissected by erosion, presenting, on the whole, an exceedingly rough and broken surface. In the vicinity of the ore deposits, the ridge-crest is a broad one, sustaining east and west slopes to the adjacent valley-bottoms on the two sides, from 30° to 45°. The valley-floors on the two sides of the ridge are formed of the middle Cambrian (Conasauga) soft shales.

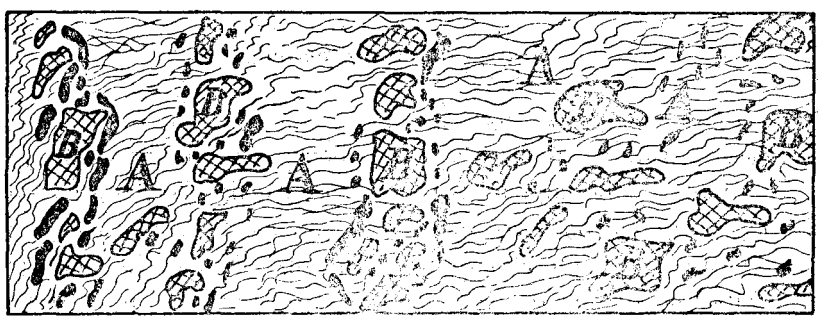
The entire surface of the ridge is entirely covered, from top to bottom, with a thick mantle of residual clay freely admixed with large masses and smaller fragments of chert, in all stages of decay. The summit of the ridge is of deep-red and chocolate clays; while the lower portions of the slope are composed of a gray to light-yellow cherty clay. No exposures of the fresh rock are anywhere visible on the slopes or summit of the ridge; but reefs and bouldery masses of chert, several square yards in dimension, are exposed on the ridge-summit above the general surface of the red clay. The chert masses are much fractured and broken, and are usually in an advanced stage of decay; and, in places, they are highly stained and impregnated with the manganese oxide. Several shafts have been sunk on the ridge-top, on the two sides of the road which crosses the ridge, just below New Prospect church. They reach a depth of from 30 to 60 feet in the dark-red cherty clay without encountering the bed-rock beneath.

Beginning on the top of the ridge, about a quarter-of-a-mile south of New Prospect church, manganese ore is scattered as loose fragments over the summit surface, for a distance of more than a mile in a direction north 30° east. The ore has been mined at several places on the ridge-summit within these limits, the principal of which are on the old HACKETT AND HICKMAN PLACES above New Prospect church, *lot 822, 3rd district;* and, further north on the following lots owned by Mr. Chas. W. Harper, of Rome, Georgia, *761, 762, 763 and parts of lots 822, 823 and 824, 3rd district,* a total of 158 acres. Mr. Harper reports that twenty-nine carloads of the ore were shipped. This was taken almost entirely from the surface.

THE HICKMAN PLACE is now owned by Mr. B. F. A. Saylor, of Rome; it has been mostly planted in peach-trees.

The first manganese mining on this ridge was done on the old HACKETT AND HICKMAN PLACES, *lot 822*, some dozen or more years ago, and a large quantity of the ore was shipped. Two log-washers were then operated near the openings, for cleansing the ore; and the water used was conveyed by pipes for a distance of two miles. A large number of openings were worked to a depth, not exceeding 15 feet, confined entirely to the surface red clay. The dark-red clay is filled with fragments of chert, usually in an advanced stage of decay. The bulk of the ore is associated with the chert in the form of breccia, and as broad bands and stringers, which generally cut the clay in a vertical position. Usually, the ore is concentrated in the clay along or near the contact of the clay with the large reefs and masses of chert, ramifying and filling the cracks

FIG. 13



Section in One of the Openings on the Hackett Lot, Reynolds Mountain, Floyd County, Georgia, Showing the Occurrence of the Ore in Association with Chert and Sandstone Fragments and Masses. A. Residual Clay, Dark-red in Color. B. Fragments of Broken Chert and Sandstone. Black Areas and Dots Indicate Ore.

and fractures in the chert. Figure 10 illustrates this mode of occurrence of the ore on this ridge. Breccia ore forms the principal type, though considerable stalactitic, spongy ore is distributed through the clay as single nodules and masses. The cavities in the porous or spongy ore are filled with the deep-red clay, in which the ore is embedded. The pocket occurrence of the ore, so common in the

Cartersville district and in the vicinity of Cave Spring, is not observed in the Reynolds Mountain deposits. It is necessary to crush and jig the bulk of the ore mined on this ridge, before washing, in order to free it from the particles and fragments of chert.

In the spring of 1902, Major J. M. Couper, of Atlanta, had some prospect work done near the old HACKETT-HICKMAN openings; but no ore was shipped. A shaft was sunk on the ridge summit, on the south side of the road crossing the ridge below New Prospect church, to a depth of 30 feet, in a dark-red plastic clay containing a considerable proportion of pellet or small gravel ore. Figure 13 shows the occurrence of the ore in the red clay in this shaft.

Brown iron ore also occurs on the ridge, in more or less close relation with the manganese. The manganese ore on the Harper lots grades into manganiferous limonite, in places.

THE D. H. LOPEZ PROPERTY

Lots 926, 927 and 998, 3rd district, are owned by Mr. D. H. Lopez, of Buford, South Carolina, and are so listed with the property owned by the same party in Polk county, page 112 of this report.

Lots 927 and 998, 3rd district, known as the HANCOCK TRACT, are located one mile east of Cave Spring. Numerous small prospect-pits have been opened, and ore was found in most of them. *Lot 927,* on which most of the mining has been done, was formerly owned and worked by Major J. M. Couper, of Atlanta. The work was all done some years ago; and the openings had considerably fallen in, at the time of my examination. One large pit, from which most of the ore mined on the lot came, exposes deep-red and yellow residual clay, containing large masses and smaller admixed fragments of chert. The chert is much fractured and broken by weathering, and the cracks are now filled with the red clay. A single pocket of ore, less than two feet in thickness, is exposed in the pit, overlain by a bed of broken chert. At this point, the chert is cut by thin seams and stringers of manganese and limonite ores, which give the rock a brecciated appearance. A considerable portion of the ore observed was of the breccia type. This property has produced a large quantity of ore.

Lot 926, 3rd district, contains one small opening, made in a red, cherty clay some years ago. From it, some manganese was mined and shipped. The ore on this lot is in the form of breccia; and its mode of occurrence and character are quite similar to that described above, on the Hancock tract, *lots 927 and 998.*

Extensive deposits of limonite occur on the lots owned by Mr. Lopez, in more or less close relation with the manganese. They are extensively mined, as well, on many of the adjoining lots.

THE LEWIS WARE PROPERTY

Lot 1009, 3rd district, known as the LEWIS WARE TRACT, is about half-a-mile northeast of the Lowe (Nancy Banks) lot, and on the same ridge. Several small pits have been opened and small quantities of the ore have been removed. The mode of occurrence and the type of ore are the same as those described on the Lowe place. The manganese is in the form of nodules and masses embedded in the red, cherty clay. Large masses and fragments of chert are commingled in considerable quantity with the residual clay. Some of the large chert masses have survived the surface weathering; and, though fractured and broken, it is moderately fresh and hard rock. Figure 11 shows the relation of the ore-bearing clay and the associated chert fragments in one of the pits on the lot.

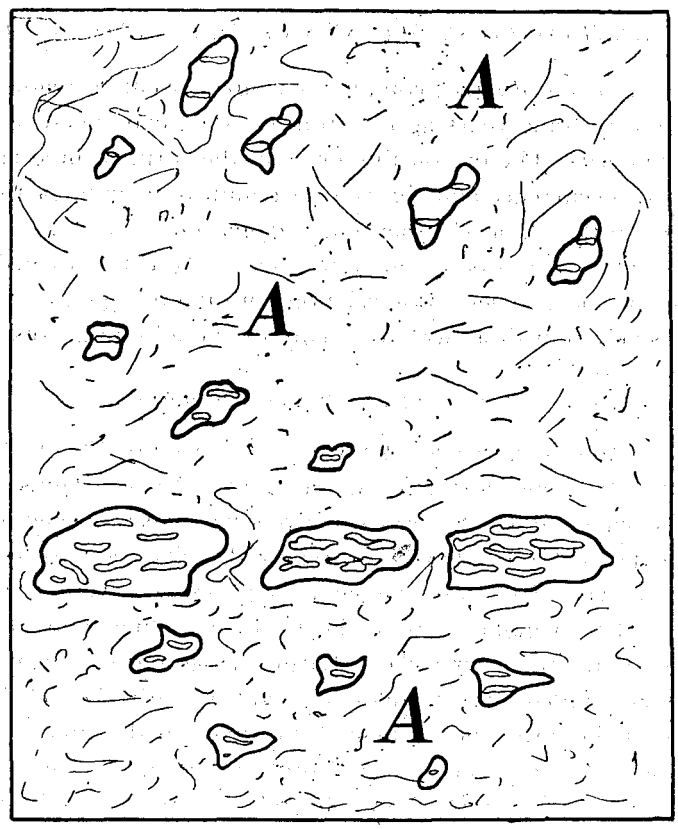
THE SIMMONS PROPERTY

THE SIMMONS PROPERTY, *lot 924, 3rd district,* is about a mile and a quarter east of the town of Cave Spring. Two small openings were made near the center of the lot, about twenty years ago, from which a small quantity of manganese is said to have been shipped. The pits are in the red clay, which contains a quantity of large chert masses, in various stages of decay. The ore was principally of the breccia type.

THE ASBURY PROPERTY

This property, *lot 1142, 3rd district, 4th section,* Floyd county, *3rd district,* one and a quarter miles east of Cave Spring. Loose fragments of breccia ore are scattered over the surface of the lots,

FIG. 14



Section in a Pit on the Lewis Ware Tract, near Cave Spring, Georgia, Showing the Residual Manganese-bearing Clay, Which Has Resulted from the Decay of the Chert Bed (Modified from Penrose). A. Manganese-bearing Clay. The Irregular Areas Represent Masses of Chert, That Have, so far, Escaped Decay.

Horizontal and Vertical Scale: 1 inch=18 feet.

in places. A few tons of the ore have been shipped from *lots 922 and 923*, taken from several small pits dug in places. The openings were only a few feet in depth, and were made some years ago. They were nearly filled by caving in, at the time of my examination; hence, the exact nature and extent of the ore deposits could not be made out. No openings for manganese have been made on *lot 950*. Limonite deposits occur on all the lots. They have been extensively worked on *lots 950 and 951*.

THE BOBO PROPERTY

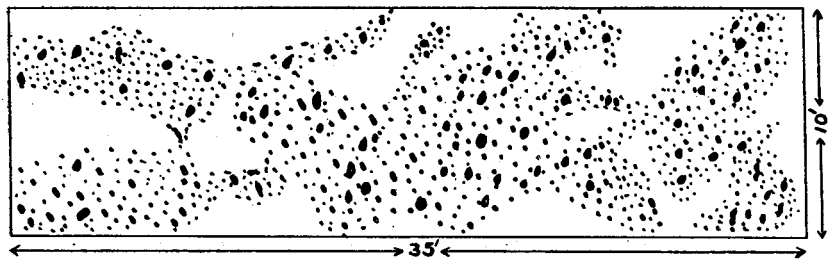
This property, *lot 692, 3rd district,* is located on a chert ridge, about one mile north of New Prospect church. Manganese, which does not occur in workable quantity, is exposed in several openings worked for limonite. The two ores are intimately associated. The limonite is a soft ore, admixed with much chert; and more than seventy carloads of the ore are reported to have been shipped. A valuable deposit of bauxite has been worked on the same lot, within a few rods of the iron ore openings, exposing the small quantity of manganese.

THE W. B. LOWE PROPERTY

This property, *lot 1,142, 3rd district, 4th section,* Floyd county, is located on the top of a much dissected, but high and steep cherty, Knox dolomite ridge, more than a mile east of the town of Cave Spring. The ridge summit is covered with a considerable thickness of red and chocolate-brown residual clays, derived from the decay of the cherty dolomite, and containing abundant fragments of the original chert bed. As a rule, the chert masses are of unusual size; and, in many instances, they have withstood disintegration to a remarkable degree.

The work done on this lot has been very extensive, and large quantities of manganese ores have been mined. The lot was worked for some time, under the control and management of Major James M. Couper, of Atlanta. Open surface work is continuous over more than an acre of ground, with an average depth of from 10 to 15 feet. The south and southeast sides of the opening expose a deep-red clay, very dark in color, entirely free from chert fragments, and closely resembling a wash-clay. The clay is closely filled with small rounded pellets and gravel of manganese, with only an occasional nodule of the ore. Figure 12 shows the occurrence of the ore in the clay at this point. On the north side of the opening, the slope is considerably higher. The section on this side shows a few feet of a deep-red surface clay, covering a light, reddish yellow-and-white clay underneath, filled with large masses of broken angular chert. Here, the ore is assembled as very small nests and string-

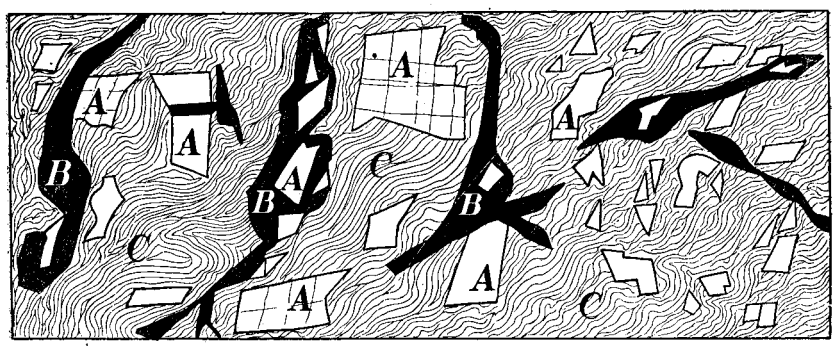
FIG. 15



Section along the South Face of the Large Opening on the Lowe Tract, near Cave Spring, Floyd County, Georgia, Showing the Occurrence of Manganese "Pellet" Ore in the Residual Clay, Indicated by Black Dots. The White Area Represents Deep Reddish-brown Clay Derived from the Knox Dolomite. No Admixed Chert Fragments Nor Nodules Are Contained in the Clay at This Point.

ers in the residual material, closely associated with the chert fragments, as indicated in figure 16.

FIG. 16



Section along the North Side of an Opening on the Lowe Tract, near Cave Spring, Floyd County, Georgia, Showing the Mode of Occurrence of the Ore in the Cherty Residual Clays. A. Chert Fragments. B. Manganese Ore. C. Residual Clay.

Several shafts have been sunk, from the bottom of the opening, to a depth of 40 feet and more, passing through light-colored clays filled with the chert masses. On the south side of the large opening, a small open-cut has been dug, from the bottom of which is sunk a shaft, 85 feet in depth. Numerous other shafts and pits have been

opened, over other parts of the lot. In most of the shafts, a heavy cherty clay, light in color, composes the material in which the openings have been made. The ore is of the spongy, cellular kind, in intimate association with the chert; and it contains much of the chert admixed with it.

This was the only property in the Cave Spring district, that was being worked for manganese during the summer of 1902. A short time before my examination of it, July, 1902, about 30 carloads of the ore were reported to have been shipped. The mine is elaborately equipped with all modern machinery and appliances, including a motor plant, for generating electricity for lighting and other purposes, and for tram-cars. It is safe to say, that this is the most elaborately equipped manganese plant in the State. The cost of the machinery and its installation must have been large; but the amount of ore contained on the property will not begin to equal the expenditure above ground.

CHAPTER V

MANGANESE DEPOSITS OF THE PALEOZOIC AREA (*Continued*)

OTHER MANGANESE DEPOSITS OF THE PALEOZOIC GROUP

INTRODUCTION

Under this heading, are included certain centres, about which are grouped a few scattered deposits of manganese ores. The centres are found over parts of the northeastern, eastern and southern portions of the Paleozoic area. Many of the deposits have been worked to some extent; but, in most cases, the work has not progressed beyond the stage of test-openings. In some cases, no openings of any kind have been made; but strong surface indications appear, which may or may not imply workable deposits below the surface. Small shipments of the ore have been made from a number of the openings; but, as yet, these scattered accumulations of the ore have proved of little or no commercial importance. Further developments, in some of the localities, may perhaps lead to important concentrations of workable ore. The mode of occurrence, association, and the mineral form and character of the ore are the same as those already described under the Cartersville and Cave Spring districts.

Following, are localities of these scattered ore deposits: — In the vicinity of Ligon post-office, in the extreme southwest corner of Bartow county, about 12 miles west of Cartersville; near Rome and Lindale in Floyd county; in Big Texas Valley, Floyd county,

12 miles northwest of Rome; in the vicinity of Barnsley and Nannie post-office, in the northwest part of Bartow county and the adjacent part of Floyd county, about 17 miles northwest of Cartersville; and the Tunnel Hill district in Whitfield and Catoosa counties.

These localities are described in some detail in the following pages.

The Ligon District, Bartow County

The Ligon district is located in the extreme southwest corner and 17th district of Bartow county, about twelve miles west of Cartersville and less than six miles southwest of Kingston. The name, Ligon district, is given in this report to a small area covering less than a dozen lots of land, on which indications of manganese ores have been observed, in the vicinity of Ligon post-office.

The Knox dolomite formation extends over the entire area. In this part of Bartow county and the adjacent parts of Floyd and Polk counties, the Knox dolomite is characterized as a slightly elevated plateau with a hilly surface. Its general altitude is under 1,000 feet; though, in a few places, occasional elevations, of from 100 to 200 feet above the 1,000-foot contour, occur. In extreme cases, the hill-tops rise to elevations of several hundred feet above the adjacent lowlands, or valley-bottoms. The accompanying map shows the general topography of the Ligon area. Here, as elsewhere over the Knox dolomite areas, the surface is covered with abundant chert nodules and fragments. The chert masses are also largely admixed with the residual clays derived from the decay of the formation. The residual covering, in the Ligon area, is a deep-red siliceous clay admixed with much chert.

Surface indications of manganese ores in the Ligon district appear as fine pellets, gravel and concretionary nodules on the following lots of land in the *17th district, 3rd section* of Bartow county: —

Nos. 368 and 369, owned by Mr. T. O. Ligon, Ligon, Ga.; *No. 373*, known as the Jacobs Lot; *Nos. 346 and 374*, the estate of Messrs. French & Tarver; and *No. 375*, the estate of a Mr. Dodd. Manganese ore is found all over the first named lot, and over the southeast corner of the second; while its occurrence has been noted

only over the middle part of *lot 373*, the south part of *lot 346*, and the southeast part of *lot 374*. It also occurs over most of *lot 375*.

The gullies and ravines on these properties all show loose, scattered ore over their bottoms; and, along the sides, much ore is assembled in the clay. No prospecting, nor work of any kind, for manganese ore has been attempted in this area.

A number of cuts expose extensive beds of limonite on *lot 422*. The surface indications are exceptionally favorable for limonite, extending for several miles, in an approximately northeast-southwest course, on lots adjoining *422*. The ores of manganese are closely associated with the deposits of iron ore; the loose fragments of manganese cover the surface on the two sides of the narrow zone, or belt, of the iron deposits.

Manganese Deposits of the Rome Area

A separate area, called the Rome district, is made, in this report, to include those occurrences of manganese ore found within a radius of six miles of the city of Rome. Greater or less quantities of manganese ore are scattered as loose fragments over the surface of a number of lots within the above limits. Less than a dozen carloads of ore have been shipped. Practically no mining has been done, and on account of lack of development, it is not possible to say, whether or not workable deposits of manganese exist on those lots, where the scattered surface fragments are found. Such surface indications as these appear, to a limited extent, to the north, east and south of Rome, limited to the decay of the Knox dolomite.

With the exception of the western portion of the area, the succession of formations in the Rome district is the same as is given for the Cave Spring district on page 103, and include sandstone, shale and limestone. The formations beginning with the oldest are: —

Beaver limestone	Cambrian
Rome sandstone and shale	
Conasauga shale	
Knox dolomite	Silurian

To the west of Rome, an extensive body of the Carboniferous rocks occurs, consisting principally of the Floyd shale, which forma-

tion is composed of black carbonaceous shale and thin beds of limestone. No deposits of manganese are yet known to occur in this area.

STRUCTURAL FEATURES. — The area to the east of Rome comprises the Knox dolomite plateau, which, if broken by faults similar to those described to the south, in the Six Mile-Silver Creek region, the lines of fracture are not apparent at the surface. The Etowah river cuts across the plateau in a general east-west direction, and is entrenched in a broad and gently sloping valley. When studied in detail, the plateau surface is seen to be much broken and dissected by smaller streams, and is characterized by a somewhat irregular, hilly surface, which is usually several hundred feet above the adjacent lowlands. The dolomite surface is covered by the residual cherty clay, and the limestone is seldom seen except along the stream channels.

To the south of Rome, as described under the Cave Spring district, the central-western margin of the dolomite plateau is broken by a number of parallel north-south faults, of the normal Appalachian type. The underlying Cambrian shales are here exposed at the surface in long narrow belts, which mark the position of deep, narrow valleys, with the adjacent and more resistant limestone blocks forming the intervening ridges. The limestone ridges are irregular and broken by weathering, and rise several hundred feet above the bottoms of the soft shale valleys.

The Rome and Coosa major thrust-faults pass through and to the west of the city of Rome, in a general northeast-southwest direction. The Rome fault is fairly regular, as is marked by the plane of contact between dissimilar formations on the two sides. In marked contrast to the Rome fault, the Coosa fault is characterized by great irregularity, shown in the strong and deep indentations along its course. In a general way, these two faults are roughly parallel. They have been adequately described by Dr. C. W. Hayes, of the United States Geological Survey, who has studied and traced them in detail.[1] Their description need not be repeated here; since the occurrence of the manganese ores is not, in any way, connected with the lines of breakage.

[1] Bull. Geol. Soc. Amer., 1891, Vol. II, pp. 141–154.

Description of Individual Properties

No workable deposits of manganese ores are yet known in the vicinity of Rome, excepting the Couper prospect described below, occurring three-quarters of a mile south of Lindale. Loose fragments of manganese ore are scattered, to some extent, over the surface of numerous lots; but no prospecting nor developments have been made. On many of the reputed manganese properties in this area, a few fragments of impure oxide of manganese may be found on the surface, which, after opening to the depth of a few feet, pass into manganiferous iron ore and finally into limonite. A number of properties within the Rome area have clearly demonstrated this fact, the most noteworthy of which are the brown iron ore deposits in the vicinity of Hermitage, where considerable quantities of the ore have been worked. Similar conditions are shown on the Bob Hill property in the *23rd district,* several miles north of east from Rome.

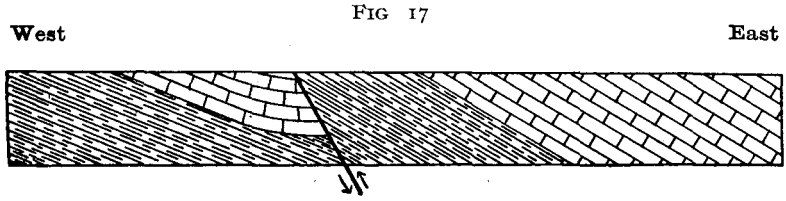
THE COUPER PROPERTY

This property, *lot 44, 22nd district,* known as the Briscoe Place, is three-quarters of a mile south of Lindale, and four and a half miles south of Rome. It is located near the inner middle western margin of the Knox dolomite plateau. Numerous faults of the normal Appalachian type, cut at short intervals the dolomite plateau in this vicinity. They extend southward along parallel lines, for a number of miles. As explained elsewhere in this report,[1] the underlying Cambrian shales are exposed at the surface, as long narrow belts in contact with the dolomite along the fault-line. The shales yield more readily to weathering than the limestone; and, therefore, they mark the positions of valleys, while the more resistant limestone forms the intervening ridges. The long and narrow fault-blocks dip steeply toward the east. Figure 14, which represents an east-west section, three-quarters of a mile south of Lindale, illustrates in a striking manner the structural relations of the rocks.

Extending southward from Lindale is an exposure of one of the long narrow belts of shale, marking the position of a valley for several miles in a north-south direction. The western margin of the

[1] See page 104.

FIG 17



Section across Valley, ¾ mile South of Lindale, Floyd County, Georgia.

valley marks the position of a fault, and about a quarter of a mile to the eastward, the shales are overlain by the heavy beds of cherty limestone. The ridge is a low one, averaging something over a hundred feet in elevation, in the more elevated portions; and its surface is irregular and broken by erosion. It is covered, in places, with chert fragments of various sizes, in all stages of decay.

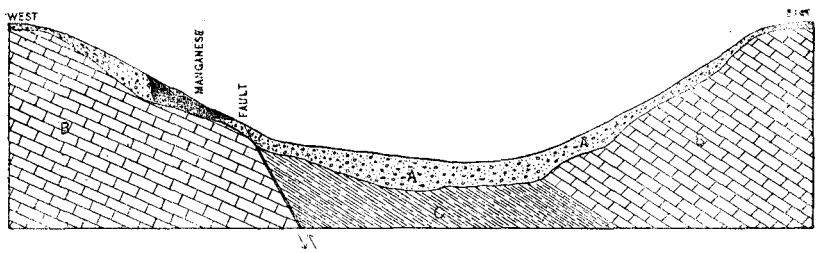
About three-quarters of a mile south of Lindale, on the west slope of the valley, and about forty feet above the valley-bottom, a number of cuts and pits were opened in 1901, on *lot 44*, in the cherty clay, derived from the decay of magnesian limestone. Considerable manganese ore is exposed in the openings. Red, yellow, white, buff and purple-colored clays make up the residual covering, in which the excavations are dug. Red clay, which is the surface covering, will average less than five feet in thickness. The underlying yellow clay which predominates is highly siliceous, and freely admixed with large and small fragments of chert, usually in an advanced stage of decay. The clays are usually stratified, the bedding-planes conforming in a general way with the ridge slope. They thin toward the top of the ridge, and are thickest in the valley. The ridge-slope in the vicinity of the deposits varies from 30° to 40°.

The ore is distributed through the clays, in the form of stringers and masses only a few inches in thickness. These stringers and masses cut the clay in various directions; and probably, in a majority of cases they conform in a general way with the slope of the ridge, which slope is coincident with the general direction of the bedding-planes. Many of the stringers are quartz, around and along which the ore is deposited as impregnations and incrustations, and as nodules and gravel. A goodly proportion of gravel and concretionary, nodular ore is embedded in the clay without any appar-

ent relation to the chert fragments and masses. The nodules, which will average from three to six inches in diameter, and are usually botryoidal in shape, are quite pure and heavy and dark steel-blue in color, and display the concretionary or layered structure; but they are not usually crystalline.

In most cases, however, the ore is closely associated with the chert, varying from impregnations, as seams of knife-edge thickness, to a ground-mass of ore cementing the fresh and partially decomposed chert fragments. The more advanced weathered fragments

FIG 18

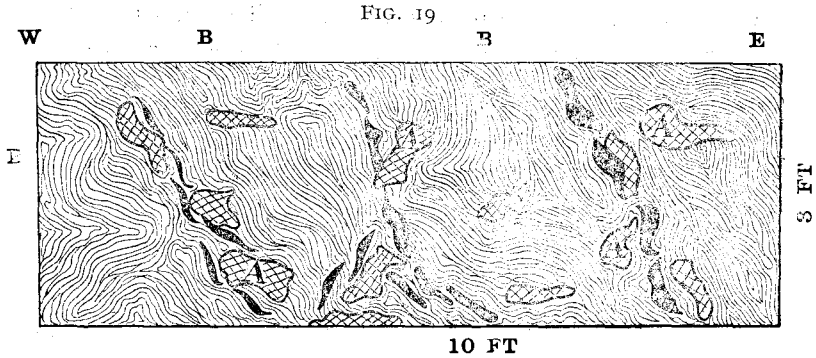


Cross-section of a Valley, south of Lindale, Floyd County, Georgia, Showing the Position of the Manganese Deposit and the Relations of the Underlying Rocks. A. Residual Clay Containing Admixed Chert and Partially Decayed Rock Fragments. B. Knox Dolomite (Magnesian Limestone). C. Conasauga Shale. The Black Area Is Manganeses.

of chert in the breccia ore, on being disturbed, readily falls out as loose sand. The form of breccia ore, usually occurring on this *lot* (*44*) is shown in the figure below. The proportion of ore to chert of the breccia mass varies widely, from the mere film of manganese oxide filling the cracks and crevices of the shattered chert fragments, binding them together, to those, in which the largest bulk of the mass is ore containing but few small chert fragments.

From this description, two distinct types of ore prevail on this lot; namely, breccia and nodular ore. Perhaps the breccia ore predominates. The greatest depth attained in working is between 12 and 15 feet, along the inner slope of the ridge. It is necessary to discard much of the breccia ore; but a good quantity of it will admit of crushing and jigging, when the ore can be fairly well freed by washing from the chert. The nodular ore is remarkably free

FIG. 19



Section in an Opening at the Lindale Mine, 4 Miles South of Rome, Georgia.

from silica, and is a very desirable ore. About four carloads of this ore are reported to have been shipped.

THE HILLYER PROPERTY

This property is located in the *22nd district*, Floyd county, about seven miles south of Rome, and was formerly known as the BONSACK ESTATE. With the exception of the Couper lot near Lindale, the conditions on the Hillyer property are more favorable for workable manganese ore than any yet examined in the Rome district. Large masses of bouldery manganese and manganiferous iron ore containing chert are exposed over a number of acres. Several small openings have been made; but, as yet, the developments are entirely too inadequate for one to judge of the extent and character of the ore.

Several small pits, near by, expose a large ore-body of ferruginous bauxite.

Limited surface indications of manganese ore are reported on the Woodruff, Wimpee, McCay, Kite and Selman properties.

BIG TEXAS VALLEY IN FLOYD COUNTY

Big Texas Valley is 12 miles northwest of Rome, in Floyd county. It occupies a synclinal of carboniferous rocks enclosed by ridges of the upper formations of the harder and more resistant Silurian rocks, the sandstone of the Rockwood formation.[1] The present

[1] Geologic Atlas of the United States, Rome Folio, United States Geological Survey, 1902.

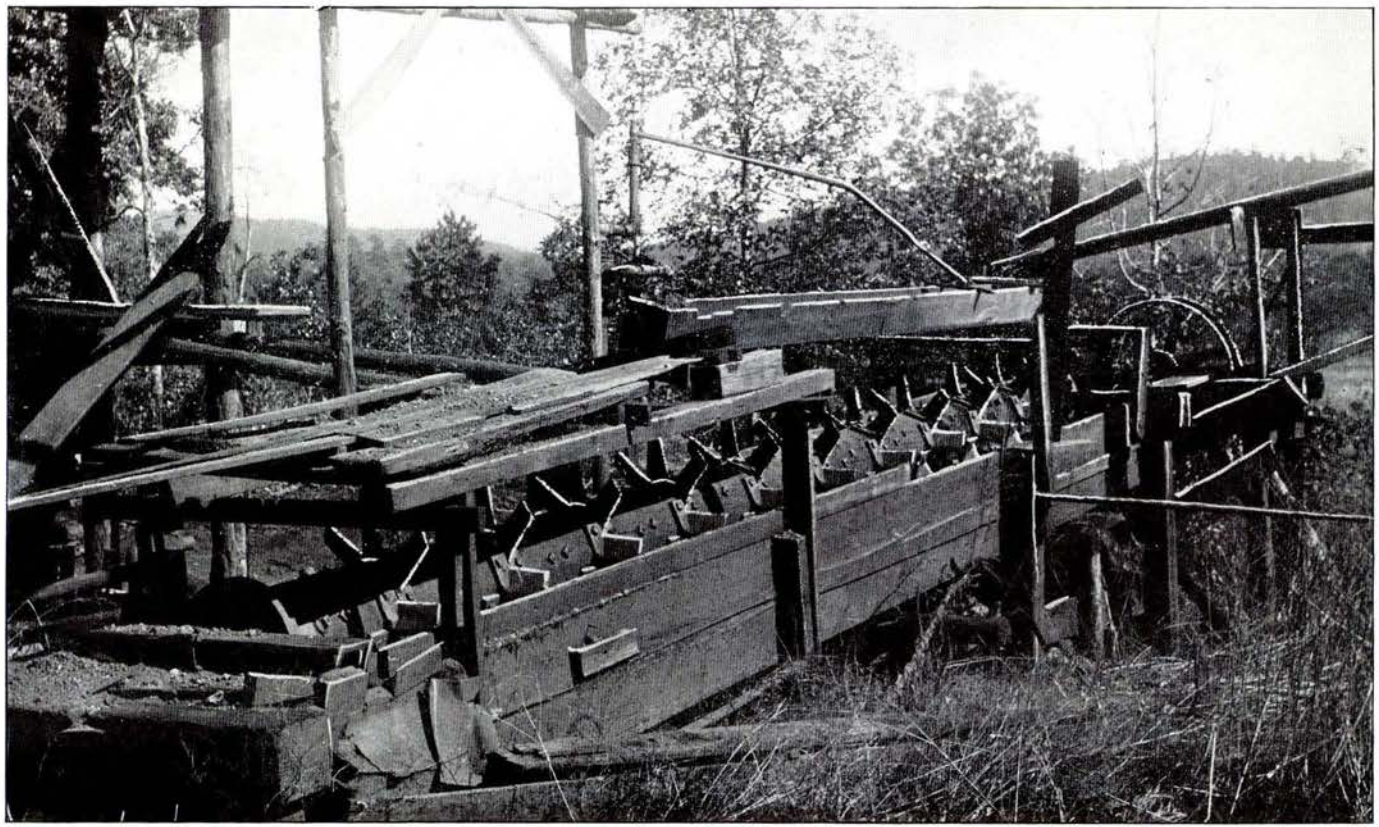
form, however, is due entirely to erosion. The valley has the outline of a deep horseshoe, with the open part to the northeast, through which its drainage is conducted into the Oostanaula river. Its axis trends northeast-southwest, along which direction the valley is divided by a low, but steeply sloping, ridge, the strata of which, on the two sides, have the synclinal attitude. The longer axis of the ridge coincides with the axis of the original syncline, and the rocks forming it occupy the position of greatest compression.

The valley is enclosed on the northwest by Simms mountain, and on the southeast, by Lavender mountain — two ridges formed of the harder and more resistant Silurian sandstone (Rockwood). They rise to fairly uniform elevations of 700 to 800 feet above the valley-bottom. Simms mountain is a monoclinal ridge the strata of which dip somewhat steeply toward the southeast, presenting the short steep slope toward the northwest. Its northeast end is an anticlinal fold. Lavender mountain is also an anticlinal ridge. The accompanying map and section will make plain the geologic features described above.

The manganese ores are found near and along the northwest slope of the inner low ridge, known as Rocky mountain. Several small openings have been made on the JOHN DAVIS LOT, *No. 94, 4th district,* Floyd county. These openings indicated only very small quantities of pure manganese ore. At very shallow depths, the ore grades into a manganiferous iron ore, and finally into limonite. Similar occurrences of manganese are found on the Fouché, King and Alexander properties. The ore is much scattered; and, when opened, it grades, near the surface, into limonite. No workable deposits of manganese ores were observed by the writer in the Valley. Some prospecting for iron ore has been done, and several hundred tons of the ore have been raised on the Alex. King and John Davis properties; but none has been shipped. The indications are favorable for large deposits of a good grade of iron ore.

THE BARNSLEY DISTRICT, BARTOW AND FLOYD COUNTIES

The Barnsley district is in the northwest part of Bartow county near the Floyd-Bartow county-line, 17 miles northwest of Cartersville. The massive Knox dolomite forms the underlying terrane in



A VIEW OF THE LOG OF A MANGANESE WASHER ON THE MILNER–HARRIS PLACE, FIVE MILES NORTHEAST OF CARTERSVILLE, GEORGIA.

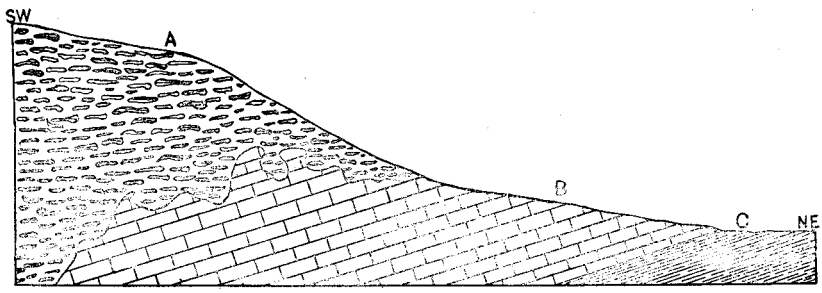
this district. Exposures of the fresh limestone are seldom seen, on account of the deep mantle of residual material. The limestone is not entirely free from folding; but such exposures of the fresh rock as occur indicate only slight dips. The underlying Conasauga shales reach the surface, as a narrow anticlinal belt, for several miles north and south of Barnsley. In a similar manner, the shales reach the surface in a more extensive exposure, several miles to the east of Barnsley, where they form the valley occupied by the Western and Atlantic railroad. The topography is the ridge-valley type. The ridges are usually low, and have steep slopes with intervening narrow and moderately deep and steep-sided valleys.

The limestone surface is everywhere covered with a thick mantle of deep-red and chocolate-colored siliceous clays, which contain numerous fragments of chert in all stages of decay. The surface is covered by loose chert fragments over most of the district, heavier in some places than in others.

Manganese ores are found in the deep-red and chocolate-colored clays, which cover the low ridges adjacent to the valley of Tom's creek. The conditions here are quite similar to those on some of the ridges near Cave Spring, described on page 105 of this report. The ore is prevailingly porous, or honey-combed, and at times stalactitic; and its cavities are frequently lined with minute drusy crystals of pyrolusite. The cavities are usually filled with the red clay. Much chert breccia occurs, formed by the angular fragments of the chert bound or cemented together by a cement of the manganese ores. Less than seventy-five tons of the ore have been mined in the entire district, and this was taken from only two or three openings. Manganese, of the character just described, is exposed in loose fragments scattered over the surface of the following lots of land in the Barnsley area and in the *16th district* of Bartow county: *Nos. 36, 63, 84 and 95,* owned by Mr. Morrow; *lot 97,* owned by Mr. Conway; and *lot 116,* owned by Mr. B. F. A. Saylor. Similar surface ores of manganese occur in places along the ridges, from the northwest of Barnsley to a point near Nannie in Floyd county, a distance of nine miles. At the latter locality, large surface accumulations of nodular manganese ores were seen on the land of Mr. E. P. Price. No openings have been made.

Deposits of both brown iron ore and bauxite occur in close proximity to the manganese; and the two former have been somewhat extensively worked near Hermitage and at other points in the Barnsley district. The accompanying figure shows the relation of the rocks in the Barnsley district.

FIG. 20



Section through the Barnsley Tract, Georgia, Showing a Manganese-bearing Chert Bed (Modified from Penrose). A. Chert and Cherty Limestone. B. Limestone. C. Shale.
Horizontal Scale: 1 inch=500 feet. Vertical Scale: 1 inch=200 feet.

Manganese ore from the Barnsley estate at Woodlands gave, on chemical analysis, the following figures to the Pittsburg Testing Company: —[1]

	Per Cent.
Manganese	43.730
Iron	1.010
Silica	3.530
Phosphorus	0.129

THE MANGANESE DEPOSITS OF WHITFIELD AND CATOOSA COUNTIES

The manganese deposits of Whitfield and Catoosa counties can best be described together, since they occur near the line between the two counties, lying partly in one and partly in the other county, and are naturally not separable. The only deposits of this mineral yet worked in these counties are in the vicinity of Tunnel Hill, a station on the Western and Atlantic railroad. They are described below under the Tunnel Hill district. The deposits are located in

[1] The Paleozoic Group, Geological Survey of Georgia, 1893, by J. W. Spencer, p. 194.

the western part of Whitfield, and the adjacent eastern part of Catoosa county, and are associated with the residual decay of the Knox dolomite.

The Tunnel Hill District

Topography.—As is shown on the accompanying map[1] of the district, the topography resembles somewhat closely that of the Cave Spring district, described on page 104, and shown on map.[1] The topography is the pronounced ridge-valley type. The ridges owe their present elevation to the exposure at the surface of more resistant strata, while the neighboring valleys or lowlands are occupied by the less resistant formations. The ridges present an irregular and broken surface due to erosion, with their greater elevations rising one hundred to two hundred feet above the adjacent valley bottoms. Here, as elsewhere in the Paleozoic area of Georgia, the topography depends primarily on the geologic structure and on the nature of the different rocks.

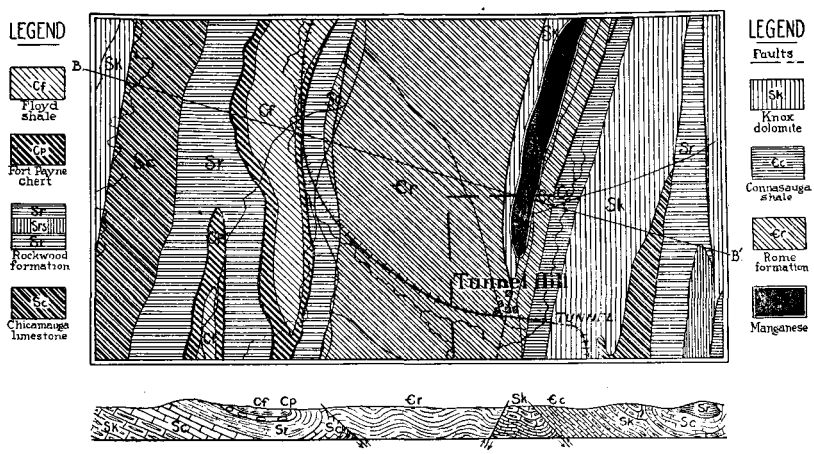
Structure and General Geology. — The rocks no longer remain horizontal; but, instead, they have been thrown into folds, and, in many cases, faulted at right angles to pressure applied from the northwest and southeast. Extending in a northeast-southwest direction, several parallel faults cross the Tunnel Hill district at close intervals to each other. These are indicated on the accompanying map.[2] The two easternmost faults head in opposite directions toward the east and west respectively. A long and narrow belt of Knox dolomite, which forms a chain of ridges at present, is enclosed between the two faults, and is in contact on the two sides with the Rome shales and sandstones. The two faults unite a short distance north of Tunnel Hill and are continuous as a single breakage-line for an unknown distance southward in the Rome (Cambrian) formation. A narrow strip of the soft Cambrian shales, marking a valley position, is in contact on the east with the belt of Rome sandstones and sandy shales; and a second more extensive belt of Knox dolomite lies to the east of the strip of Cambrian shales.

The formations, represented in the Tunnel Hill district, shown on the map,[2] range from the Rome (Cambrian) shales and sand-

[1] See Fig. 9. [2] See Fig. 21.

stones to the Floyd shales and Bangor limestone inclusive, of Carboniferous age. The shales, sandstones and limestones, mentioned above, have been continuously exposed to the attack of atmospheric agencies, since the close of Carboniferous time; and they are consequently mantled with a heavy covering of residual decay, derived from them by the usual processes of weathering. The Knox dolomite is the formation of particular interest in this area, since it is only in the residual clays of the magnesian limestone that the manganese deposits are found.

FIG. 21



Geological Map of the Tunnel Hill District, Georgia, showing the Distribution of the Manganese Deposits, by Thomas L. Watson. Based on the Ringgold Folio, U. S. Geological Survey.

DESCRIPTION OF THE MANGANESE DEPOSITS IN THE TUNNEL HILL DISTRICT

The only manganese mining in the Tunnel Hill district was done by the Catoosa Mining Company from 1890 to 1893 on its property two miles north of Tunnel Hill. Less than thirty cars of manganese

and manganiferous iron ores were shipped from this property, which represented the total shipment of manganiferous ores from the entire district.

THE CATOOSA MINING COMPANY'S PROPERTY

This property includes the following 160-acre lots of land: *Nos. 250, 251, 254, 255, 256, 286, 287, 288, 289, 290, 11th district, 3rd section,* Catoosa county, *and No. 324, 11th district, 3rd section,* Whitfield county.

The mining done on this property is near the dividing line between Whitfield and Catoosa counties, the property being partly in one and partly in the other. The openings begin about two miles north of Tunnel Hill, and are found at intervals on this and adjoining properties in a northeast direction, for a distance of six miles northeast of Tunnel Hill. The most northerly openings are on Mr. Jacob Messimore's property, six miles northeast of Tunnel Hill, where several shafts have been sunk with fair results.

The deposits of manganese are embedded in the residual clays of a narrow belt, consisting of a chain of broken ridges, which extend northwestward from Tunnel Hill into Tennessee. The elevations along the chain of ridges are quite variable, rising, in most cases, between 100 and 150 feet, with extreme altitudes of more than 200 feet further northward. The underlying rock, composing the ridges, is the Knox dolomite, capped by a considerable depth of residual decay derived from this formation. Both gray and red cherty clays constitute the decay from the limestone, usually showing but little chert exposed on the surface. The gray cherty clays greatly predominate, with the ore distributed usually through the red clays, which are of variable depth. A shaft is reported to have been sunk in the cherty clays to a depth of 210 feet without striking the underlying fresh rock. Exposures of the fresh rock were seldom observed.

The Catoosa Mining Company has made a large number of extensive openings, which extend over a distance of about two miles, in a northeast-southwest direction. Excavations on the property include open-cuts, tunnels and shafts. Many of the numerous shafts,

sunk at different places over the property, will average more than 100 feet in depth. In the deeper ones, drifts are reported to have been run at every 25-foot level in the shafts. One shaft, attaining the depth of 150 feet, is said to have encountered manganiferous iron for most of its depth. At the time of my visit, the openings had all fallen in and the exact conditions of the ore and the enclosing clay were difficult to make out. The dumps have been well cleansed of ore; and they left practically nothing to be seen in this particular.

The ores are enclosed in the red clays as is shown in the numerous openings, which contain large masses of chert in a more advanced stage of decay, as a rule, than that commingled with the clays of the Cartersville and Cave Spring districts. For this reason, the quantity of chert fragments admixed with the clays is less than in the two districts just mentioned. The character of the ore closely resembles that of the Cartersville district. It consists mostly of botryoidal and kidney-shaped nodules, varying from one inch to twelve and more inches in diameter, composed usually of a crystalline interior. The best exposures of the ore were seen in a number of large cuts near the northern limits of the property. Here, the ore is of the character already described, heavy and crystalline massive nodular, and generally remarkably free from quartz grains and fragments. The nodules are scattered as single lumps through the clay, and are concentrated in the form of pockets.

The openings nearest Tunnel Hill show limonite and manganiferous iron ores, much of which is of the breccia type, the ore containing a considerable proportion of decayed chert fragments held together by the matrix of ore. Deposits of the limonite occur in close relation with the manganese ores in numerous places on the ridge. In these places, the brown ore is more abundant than the manganese, and it occurs in pockets and lenticular layers, the latter often attaining a thickness of 20 feet. The iron and manganese ores occur, in some places, intimately mixed as manganiferous iron ore; also, as separate and distinct ores, in the same deposit; while in other places, they occur as separate deposits without any intermixture whatever.

Penrose makes the following statement regarding the occurrence

of the ore in place in the rock: "In a pit at the base of the hill, manganese ore occurs in place in the rock, which is often of a characteristic brownish-chrome color, is hard, and has a conchoidal fracture. The ore is found in it in layers or nests, and frequently the rock is studded with numerous small black, concretions of ore the size of mustard seeds. In some places the nodules have weathered out of the rock and lie in the clay on its partly decomposed surface."[1]

No occurrence of the manganese ores in place, in the original rock, was observed by the writer; but that they were originally disseminated through the rock, in some form, can not be doubted.

Very extensive preparations for mining on this property were made by the company, involving a considerable outlay of money. A manganese plant, equipped with the necessary modern machinery, was built, and several miles of railroad laid to the openings for conveying the ores to the mill.

OTHER MANGANESE PROPERTIES IN THE TUNNEL HILL DISTRICT

About six miles northeast of Tunnel Hill, on the same chain of ridges, several shafts were sunk on Mr. Jacob Messimore's property, in Catoosa county, with favorable results. On the adjoining property to the south, known as the Dempsey property, and five miles northeast of Tunnel Hill on the same ridge, some openings were made in 1892, exposing both manganese and limonite, similar to that on the Catoosa Mining Company's property. From four to six miles southwest of Tunnel Hill, and on the southwest extension of the same ridge as the properties above described, scattered fragments of manganese ore are found, to a limited extent, over the surface of properties in Whitfield county, belonging to the following persons: Messrs. W. H. C. Freeman, S. P. Anderson, John Carr of Whitfield county, and include *lots 166, 195, 202, 231, 238 and 267*. This part of the ridge presents the same general characters, as are given above, for its northeastern extension beyond Tunnel Hill. No excavations have been made, and the quantities of ore scattered over the surface were not large.

[1] Penrose, R. A. F., Manganese: Its Uses, Ores and Deposits, Ann. Report, Geol. Survey of Arkansas, 1891, Vol. I, pp. 430–431.

From five to seven miles northeast of Tunnel Hill, in Whitfield county, near Varnell's station on the Southern Railway, manganese ores were reported to the writer as occurring on the Spann, the Crow, the Murphy and the Williamson properties. On examining these properties, scarcely a trace of manganese was observed; and all the test-pits visited, which afforded evidence of ore, showed either hematite or limonite, with no manganese nor manganiferous iron ore exposed.

CHAPTER VI

GENESIS OF THE MANGANESE DEPOSITS OF THE PALEOZOIC AREA

Before formulating any theory of the origin of the deposits of manganese ores in the Georgia Paleozoic area, it will be necessary to briefly review the general geologic conditions and mode of occurrence of the ore deposits, which are more fully discussed elsewhere in this report.

STRATIGRAPHIC POSITION OF THE ORES. — The manganese ores of the Paleozoic area are limited entirely to the deep mantle of residual material, derived from the decay of limestones and quartzite. Named in ascending order, the formations, in the residual decay of which the ores are enclosed, are: the Weisner quartzite, the Beaver limestone, and the Knox dolomite—Cambro-Silurian in age. The ores occur with about equal frequency in the residual decay derived from the three formations.

CHARACTER OF THE DECAY. — The loose material, covering the hard, unaltered rocks of the area, is that which results entirely from the action of atmospheric agencies; and, as such, it rests directly on the rocks from which it is derived. Away from the contact zones between the formations, the decay is characteristic of the different rock formations from which it is derived, and it is easy of differentiation. Along the contact between the formations, more or less intermingling of the *residua* takes place, and differentiation is less easy.

In composition, the residual material varies from highly siliceous to deep red, ferruginous clays. Variation in color ranges from light-gray and yellow, through the light and deep shades of red, to chocolate-brown and black. Much white clay is locally encountered in

the siliceous *residua* of the quartzite. Fragments of the parent rocks, of varying sizes, and representing all stages of decay, are mixed in greater or less proportion with the clays. In texture, the *residuum* varies quite markedly; but it is usually sufficiently porous to readily admit of easy percolation of the atmospheric waters.

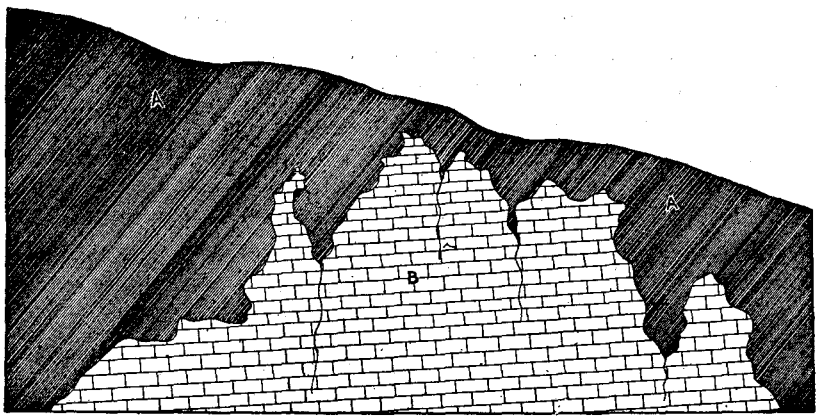
The essential differences in the residual material, here mentioned, are clearly those, which obtain in the decayed product derived from rocks, so markedly different in composition as limestone and quartzite.

Depth of the Decay. — Over the limestone areas, exposures of the fresh rock are seldom seen; and, with one or two exceptions, mining operations have not reached depths, greater than the thickness of the residual clays; but they are confined within the limits of the decay. On the Knox dolomite ridge to the south of Rome, known as Reynolds mountain, manganese openings expose the partially decayed cherty magnesian limestone, at slight depths beneath the red clay. The irregularity in depth of decay derived from the Knox dolomite is well brought out in the figure below of a section two miles east of Kingston.

Exposures of the fresh rock are more frequent over the quartzite area, particularly along the crests and near the tops of the steeper slopes of the higher ridges. Disconnected reefs and large, broken, angular masses of the fresh quartzite rise many feet, in some cases, above the residual decay on the ridge crests. The depth of decay rapidly increases in passing from the ridge tops to the valley bottoms. In the Chumley Hill district of Bartow county, several shafts have reached depths of more than 80 feet in mining manganese, without piercing the bed rock.

Mode of Occurrence of the Ores. — As stated above, the manganese ores are entirely limited to the residual material resting upon the limestone and quartzite. In no case, have I found the ores in place in the fresh rock; and, in several excavations in the Cartersville district, on the slopes and near the ridge-tops, I have observed veins of the ore, filling the cracks which intersect the shattered and moderately fresh quartzite, the origin of which has beyond question been from the percolating waters above, bringing in

FIG. 22



Section in the Knox Dolomite, 2 miles East of Kingston, Georgia, Illustrating Weathering of the Magnesian Limestone (Modified from Spencer). A. Residual Clay. B. Fresh Magnesian Limestone.

and precipitating the manganese. Doctor Penrose states, that the ore often occurs in position in the solid rock, similar to that in which it is now found in the clay.[1] This may be true, in a few cases, though the writer has found no evidence of it in the field.

The ores occur in the clay, in the form of disseminated grains or pellets, concretionary nodules and masses, pockets or lenticular layers, and stringers. As a rule, the ore-bodies irregularly cross the bedding of the enclosing clay; though, at times, they appear to conform in a general way to the bedding. The disconnected and irregular character of the deposits often renders this tendency obscure. Even though the ores, in a general way, conformed at all times with the bedding of the enclosing clays, it would not necessarily argue for the similar position of the ores in the original rock. For, in an area like Georgia, where the rocks are thrown into sharp folds with steep dips, the bedding-planes would offer the easier and more natural lines for the percolating waters. Along these directions, the decay would be augmented, and the precipitation of the manganese would take place.

The ore-bodies vary greatly in size, ranging from mere nests to

[1] *Op. cit.*

pockets or lenticular layers, from six to eight feet thick and from thirty to forty feet in length. The more solid pockets of ore consist of concretionary masses and nodules, more or less closely assembled in the clay. Occasionally, the smaller pockets or nests are free from clay, and consist of pure nodules and masses of the ore. The pockets may occur close together or far apart. If close together, they not infrequently are connected, in an irregular way, by stringers and thin seams of the ore.

Much breccia ore occurs in places, especially in the quartzite area and the more cherty horizons of the Knox dolomite. Here, the broken fragments of the quartzite and the cherty masses of the limestone have been cemented together by the ore deposited from percolating waters. The proportion of ore to rock, in the breccia type, varies greatly; from masses, in which the ore predominates, to those, in which the rock composes the greater bulk, with all intermediate gradations.

The ore exists entirely in the form of the oxides of the metal, and is usually entirely or partially crystallized. Its usual form is that of concretionary lumps and nodules, as mammillary masses, simulating bunches of grapes, potatoes, etc. A less common variety is that closely resembling the stalactitic form. The layered structure of the nodules is often composed of either the fibrous or granular crystallization or both.

Distribution of the Ore in the Clay. — The distribution of the ore in the clay is an extremely irregular one. Locally, the ore-bodies may be grouped quite close together; more often, however, they are far apart. No exact estimate of the ratio or proportion of clay to ore can be made as a whole; but it is usually larger than in the associated deposits of brown iron ore. Only locally, can approximations be made; and these will vary widely, from place to place. Over most of the area, the clays are almost entirely barren; or else they contain only traces of the disseminated ore, particles and larger fragments.

As deep as mining has yet reached, it is significant, that the vertical distribution of the ore is marked by as great irregularity as that of lateral or horizontal distribution. Such a distribution of the ore would oppose any theory of accumulation and concentra-

tion along certain more impervious rock masses or layers, as some have ascribed to certain of the more northerly deposits of manganese of the Atlantic border region. The ore bears every appearance of deposition from solutions percolating through the residual clays.

ASSOCIATION OF THE MANGANESE WITH OTHER ORE DEPOSITS OF THE AREA. — The manganese ores are somewhat closely associated with important commercial deposits of brown iron ore, yellow ocher and bauxite.

The deposits of iron all contain traces of manganese, and most of the manganese contains traces of iron; but the principal deposits of the two metals are quite distinct from each other. According to origin, several distinct types of limonite, or brown iron ore, occur in association with the manganese, in the Georgia Paleozoic area, grouped by Hayes as follows:[1] (1) gossan ores; (2) Tertiary gravel ores; (3) concentration deposits; and (4) fault deposits. Other forms of iron ores occur, but they are of less importance within the immediate manganese districts. Only the concentration and fault-deposits concern the discussion of the genesis of the manganese accumulation.

Hayes refers to the concentration-deposits of the Cartersville District, Georgia, as follows:[2] "At various times these valleys [limestone] have received the drainage not only from the adjacent quartzite and limestone, but probably also from other of the valley-formations; and the widely disseminated iron leached from these formations during the process of decay has been transported to the limestone valley, and there concentrated upon the underlying impervious quartzite." The principle underlying the genesis of the concentration-deposits is well expressed in the following sentence by Hayes:[3] "They [brown iron ores] may occur wherever a limestone is underlain by an insoluble and impervious stratum, such as sandstone or quartzite." He further says:[4] "Favorable conditions for this accumulation occur in northwest Georgia and Alabama,

[1] Geological Relations of the Iron Ores in the Cartersville District, Georgia; Trans. Amer. Inst. Mining Engineers, 1901, Vol. XXX, p. 411 *et seq.*

[2] *Ibid.*—pp. 412-413.

[3] *Op. cit.*, p. 412.

[4] *Ibid.*—p. 412.

at the contact of the lower Carboniferous limestones with sandstones which sometimes underlie it, and at the contact of the Beaver limestone with the underlying Weisner quartzite." The second type of iron ore deposit of the area is that genetically related to the faults, which intersect the area, and are designated by Hayes as fault-deposits.

The yellow-ocher deposits are closely associated with those of manganese; and the only ones found in the Georgia Paleozoics are located in the Cartersville district, Bartow county. The ocher is also closely associated with the brown iron ores of the district. Beginning at a distance of about five miles southeast of Cartersville, the ocher belt has a northward extension of about eight miles, confined entirely within the Weisner quartzite formation, which has been greatly crushed and fractured from compression and faulting. They are entirely in the nature of replacement-deposits in the shattered quartzite, the silica of the quartzite having been removed in solution, and the hydrated ferric oxide substituted.[3]

The last type of ore deposit in the area, with which manganese is somewhat closely associated, is bauxite. The ore-bodies are distinct pocket deposits, having the vertical and lateral dimensions about equal. They are enclosed in the residual clays derived from the decay of the Knox dolomite. They were first shown by Hayes,[4] and afterwards confirmed by the writer,[5] to represent accumulations of hydrated aluminum oxide in vents or springs located along the lines of the numerous faults, which intersect the area. The source of the alumina was from below, in the underlying aluminous shales of the Conasauga (Cambrian) formation; and it was taken in solution by the hot ascending waters circulating along the lines of fracture.

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3 *Ibid.*—p. 415 *et seq.*

Watson, Thomas L. The Yellow Ocher Deposits of the Cartersville District, Bartow county, Georgia., Trans. Amer. Inst. M. E.. 1603 Author's Edition, 24 pages.

A Preliminary Report on the Ocher Deposits of Georgia, Geol. Survey of Georgia; Bull. No. 13, 1906, pp. 57-65. By Thomas L. Watson.

4 Sixteenth Ann. Rept. U. S. Geol. Survey, 1895, Part III, pp. 587-591.

5 The Georgia Bauxtie Deposits, American Geologist, 1901, Vol. XXVIII, pp. 38-45.

A Preliminary Report on the Bauxite Deposits of Georgia, Geol. Surv. of Georgia; Bull. No. 11 1904, p. 169. By Thomas L. Watson.

GEOLOGIC STRUCTURE OF THE AREA. — In addition to the intense folding of the rocks of the area, it is intersected by numerous faults, which are grouped, on account of certain differences, into two classes (a) major thrust faults, and (b) minor thrust faults. The position of the faults is indicated in places by breccia zones; and some of the formations, particularly the quartzite and shales, have been greatly fractured and shattered by the intense compressive force exerted along a northwest-southeast direction. Careful study in the area conclusively shows, that some of the ore deposits mentioned above are directly related genetically to these lines of breakage; while other somewhat closely associated deposits show from field-study no relation whatever to the faults. Distribution of the manganese ores and other field evidence show the manganese to be quite independent of the faults, and not in any way are they genetically related.

STATEMENT OF THE HYPOTHESIS

The wide occurrence of manganese under different conditions in various regions, indicates, that its origin has not everywhere been the same. In some localities, it occurs as a replacement deposit; in others, the ores existed, in their present form and position in the rocks of the region, before weathering, and are therefore strictly residual deposits enclosed in the decay derived from the rocks containing the manganese. In still others, the ores are regarded as entirely secondary deposits, and their present distribution in workable form has been determined largely by chemical and physical conditions, rather than by the outcrop of beds especially rich in manganese. Modifications of the two last statements of ore genesis, more particularly as regards the source and method of accumulation have been urged by some for the occurrence of manganese ores in certain localities. With the exception of the replacement type, and possibly some vein and fault deposits, the ores exist in more or less concentrated form in the residual decay derived from the underlying rock; and, to this extent, they must be regarded as secondary residual accumulations.

SOURCE OF THE MANGANESE. — The proximate or immediate source of the manganese was from the rocks, from which the residual

decay enclosing the ores was derived by weathering. Accumulation was likely not entirely limited to the manganese contained in any single formation, in the residual decay of which the ores now exist, but was derived from any one or more, or all, formations containing this element, formerly covering the one, in which the ores are now found. Evidence is not entirely lacking to support this statement. The decay, covering the Weisner quartzite of the Cartersville district, is easily separated into a deep-red, less siliceous material, of variable thickness, overlying a light-gray and yellow-colored siliceous decay, resting immediately on the quartzite. The line between these two residual products is usually a sharp one. A study of the two indicates such differences, as can best be explained, on the assumption, that they were derived from superposed formations of different rock types, such as limestone and quartzite. The top and deep-red product closely resembles the decay, known to be derived from the Beaver limestone; while the underlying product resting on the quartzite is characteristic of the quartzite decay. Manganese occurs in both products; but it is more abundant, and is more localized, in the larger openings in the underlying light-colored siliceous decay. If this observation is correct, the Beaver limestone was once extensive over the present quartzite area; and the manganese ores in the quartzite decay have probably been enriched from that, existing in the once overlying fresh limestone.

As shown from the general geologic distribution and the mode of occurrence of the ores discussed above, the source of the manganese could not have been derived from rocks underlying those, in the residual decay of which the deposits are now enclosed.

The Paleozoic rocks are bordered on the east and south in Georgia by older crystalline rocks, from which the former rocks were largely derived. It is shown elsewhere in this report, that the crystalline rocks, made up in part of original igneous masses and in part of original sedimentaries, are composed of numerous complex silicates, many of which are manganese-bearing. The original source of the manganese in the Paleozoic rocks is believed to have been derived from the neighboring older crystalline areas.

Microscopic study of a number of thin sections prepared from hand-specimens of the quartzite, collected from all parts of the

A MANGANESE ORE-WASHER ON THE MILNER–HARRIS PLACE, FIVE MILES NORTHEAST OF CARTERSVILLE, GEORGIA

quartzite area, fail to disclose any mineral substance, that could be definitely referred to manganese in any mineralogical form. In order to further test the absence or presence of manganese in the quartzite, large fragments were chipped from each of the hand specimens, mixed and powdered as one sample. From this bulk of powdered quartzite a sample was carefully taken and subjected to a chemical analysis, searching particularly for manganese. The results of the analysis, made by the N. P. Pratt Laboratory, Atlanta, are as follows: —

	Per Cent.
Silica, SiO_2	90.36
Titanic Oxide, TiO_2	0.07
Alumina, Al_2O_3	1.52
Iron Sesqui-oxide, Fe_2O_3	0.57
Lime, CaO	0.27
Magnesia, MgO	0.27
Manganese Oxide, MnO	none
Soda, Na_2O	0.43
Potash, K_2O	0.16
Water, H_2O, at 100° C.	none
Water, H_2O, above 100° C.	0.31
Iron sulphide, FeS_2	1.50
Barium Sulphate, $BaSO_4$	4.46
Total	99.92

It will be observed, that the chemical results confirm the microscopic study. It would not be entirely safe to conclude from one analysis, that manganese was wholly absent from the formation, even though it were made from a sample prepared from hand specimens of the rock taken over all parts of the area. When added to similar results from microscopic study, however, the two greatly strengthen such an inference. If the results should later prove conclusive, the source then of the manganese in the residual decay of the Weisner quartzite must have been the once existing overlying formations, which, on weathering, released the manganese, and it was concentrated by chemical and physical agents in the quartzite decay. Or else, the manganese, now found in the decay of this formation, was limited to that part of the formation reduced to

decay. This, of course, is not impossible; but the writer has found no field evidence in support of it.

Unfortunately, sufficient data are lacking, upon which to base a statement of the absence or presence of manganese in the overlying formations.

From the close analogy of concretionary structure, and, to some extent, of chemical composition, between the manganese nodules of deep-sea dredging and the similar forms of the ore occurring in the decay of the rocks extending from Nova Scotia to Georgia and Alabama, it has been urged by some, that the source of the manganese was in the sea-waters, and that these ores have had an origin similar to that of the deep-sea forms. The geologic history of the Paleozoic area of Georgia is fairly well known; and the distribution of the manganese deposits is in disconnected areas, along the eastern and southern margins of the Paleozoic rocks, the parts nearest the crystalline border. This, from a study of the rocks, points to a shallow-water zone near the old shore-line.

SOLUTION, TRANSPORTATION AND PRECIPITATION OF THE MANGANESE OXIDES

Assuming then that the original source of the manganese was from the older crystalline rocks, to the east and south, it remains to show, how the manganiferous material reached its present form and position.

The crystalline rocks of Georgia are composed chiefly of granites, gneisses, schists, and basic igneous masses; and they are everywhere deeply decayed, the unaltered rock lying buried under a thick covering of the residual clays. The essential minerals in these rocks are silicates, many of which are manganese-bearing. Decay in this southern region has been promoted largely by chemical changes in the mineral constituents of the rocks, resulting in mineralogical combinations, of simpler and more stable form, totally different from the original forms. Atmospheric oxygen, water, carbonic and organic acids, and, to a less degree perhaps, certain inorganic acids, combined, have been the principal agents involved in the chemical decay of the rocks. Accompanying such changes, the metallic bases

of the silicates combine with the various acids, and are removed in solution as salts of these acids, the insoluble parts of the minerals remaining where formed, to make up the residual mantle. Manganese, with other of the base-forming elements, is thus removed in solution by the streams; and, under favorable conditions of oxidation it is finally precipitated with the sediments on the floor of the water-bodies, into which the streams drained.

Manganese is usually precipitated or deposited as oxide or carbonate, or both; rarely, as sulphide. Of these, deposition in the form of the carbonate is the more usual, perhaps, and this is subsequently converted into the oxide.[1] Definite field evidence that would indicate the exact form, in which the manganese was laid down in the rocks, was lacking, in the area studied by the writer. The observations of Penrose indicate, that a part at least of the manganese was originally deposited as the oxide. If the original source and process of deposition of the manganese, as outlined above, be admitted, it is reasonable to assume, in the absence of positive evidence, that deposition of the manganese, probably in the form of both carbonate and oxide, took place to some extent.

After examination of the chemical behavior of manganese, Dunnington calls attention to the probability of manganese sulphate having taken an important part in the formation of deposits of manganese ores. In view of the results from this examination, he says: "— it appears possible, that many deposits of manganese in calciferous rocks owe their formation to the action of solutions of sulphates, and possibly an illustration of such action is presented in the manganese deposits of Crimora, Augusta county, Virginia . ."[2] Professor Dunnington then outlines the conditions, under which he conceives the Virginia deposits to have been formed.

LOCAL ACCUMULATION OF THE MANGANESE. — Any manganiferous material, originally deposited as carbonate, is first converted to the oxide during the process of weathering. If, as indicated, the manganese was regularly or irregularly disseminated, in a very finely divided state, through the limestones and quartzites in

1 R. A. F. Penrose, Ann. Rept. Arkansas Geol. Surv., 1890, Vol. I, p. 550 *et seq.*

2 F. P. Dunnington, On the Formation of the Deposits of Oxides of Manganese: Amer. Jour. of Science, 1888, Vol. XXXVI (3rd S.), p. 177.

greater or less quantity, then some secondary action or process must explain their present local accumulation. Segregation of the finely disseminated particles of manganese, to any appreciable extent, if at all, does not appear to have taken place in the original unweathered rocks. The agencies, which promoted the decay of the rocks and the enclosing of the manganese particles, were those involved in the accumulation of the ores in their present concentrated form. The process, involved in the local accumulation, was largely one of resolution of the manganese by the acidulated surface waters and its reprecipitation in another position in the residual clays. Segregation by this process was necessarily a slow one, and it is being carried on at the present time.

The irregular distribution of the ores in the residual clays, both laterally and vertically; the frequency, with which the ore-bodies are observed to cut across the bedding of the enclosing clays, and without regard to orientation in any direction; the invariable presence of greater or less quantities of included quartz grains and other particles of siliceous material, irregularly distributed through the nodules and masses of ore, of the same character as that composing the enclosing clay; the concretionary nodular and stalactitic forms of the ore and its prevailing tendency to crystalline structure; are the most pronounced features of the ores, and are those, which would result from such a process of segregation as outlined. That is, they are secondary accumulations, resulting from chemical and physical action, during the decay of the rocks containing the manganese.

Abundant masses of breccia ore are associated, to some extent, with other types of the ore, in all the deposits; but they are especially characteristic of the lower zone of decay of the quartzite, which consists of only partially decayed and broken masses of the rock, over the quartzite area. The formation of the manganese breccia masses is due to the downward percolation of the manganiferous solutions, through the overlying mantle of finer decay, into the cracks and crevices, which separate the rock fragments, and the precipitation and deposition of the manganese oxide in the spaces separating the rock fragments. In the Cave Spring district, where broken masses and beds of chert from the Knox dolomite abound, a similar formation of chert breccia is observed. In some instances, the percolation

from above has extended into the cracks of the moderately fresh rock below, with deposition of manganese forming intersecting veins in the rock.

The frequent black color of the ore-bearing clays, especially noticeable near the ore-bodies, due to the presence of very finely disseminated particles of manganese oxide, finds explanation in the precipitation of the manganese as oxide from the permeating solutions. All these associations and different types of the ore are regarded as products of secondary chemical and physical action.

Finally, this process of local concentration of manganese has its analogy in the present accumulation of manganese in the residual decay of the crystalline rocks throughout the Southern Appalachians. The writer has observed, in his field-studies of rock weathering in parts of Virginia, the Carolinas and Georgia, that, in the weathered materials of these rocks, some of the minerals which were manganese-bearing, the decay is colored black in spots, from the oxide of manganese; and knife-edge stringers of the manganese are frequently found filling the cracks in the clays.

CHAPTER VII

MANGANESE DEPOSITS OF THE CRYSTALLINE AREA

The Crystalline Area of Georgia

POSITION AND LIMITS OF THE AREA

The position of the Crystalline Area is shown on the map accompanying this report. The area includes two physiographically distinct provinces, namely, the Appalachian mountains and the Piedmont plateau. The transition in the rocks of the plateau, along its northwest margin, to those of the mountain province is indistinctly marked, and is not sudden, but usually gradual. Topographically, the exact limit between the two is equally difficult to define, since the elevation of the plateau near the border of the Appalachian province is not sharply contrasted with that of the southeast margin of the latter province; but the slope of the one passes more or less gradually into that of the other.

The Crystalline Area might, with propriety, be designated the middle province of the State, bounded, as it is, on the northwest and southeast, by the two geologically distinct areas, termed the Paleozoic Group and the Coastal Plain. It is separated, on the southeast, from the Coastal Plain, by an irregular line drawn from Augusta south of west through Macon and Columbus, known as the "Fall-line." The line marks the contact, formed by the overlapping Coastal Plain sediments on the crumpled crystalline rocks of the Piedmont plateau. On the northwest, the Crystalline Area is separated from the Paleozoic Group by the "Cartersville fault," which has been defined as an irregular line, entering the State in Murray county, and passing near Cohutta Springs southward and

to the east of Cartersville in Bartow county, and thence south of west through Polk county into Alabama.

The area, as thus defined, crosses the State in a general southwest direction, and with the exception of the extreme ten northwest counties, it occupies the entire north part of the State.

ROCKS OF THE CRYSTALLINE AREA

With but few exceptions, the rocks of the Crystalline Area include profoundly altered original clastic and igneous masses — crystalline metamorphic rocks. Some of the granites and most, if not all the more recent basic dike rocks, retain in the field, their original characteristic massive structures. I have previously shown, however, that, while many of the granites of the Piedmont area afford no outward visible evidence of metamorphism, when examined in thin sections under the microscope, they invariably display some effects of pressure metamorphism.[1]

Many different mineralogical types of rock are represented in this area. Metamorphism has been so complete in many, that it is often impossible to say with certainty, whether they were derived from original sedimentary or igneous masses. Granites, gneisses, schists, slates, limestones and quartzites, or sandstone, compose the principal rocks. These are cut by numerous intrusions of more recent basic igneous rocks, in the form of dikes of diabase, diorite and gabbro, comprising the commonest types of the dike rocks. Mica- and hornblende-schists are the most widespread of the crystalline schists. The granites and a part of the gneisses are prevailingly mica rocks.

Excepting the more recent basic dike rocks, which are of Mesozoic age, the entire Crystalline Area is one of great complexity. The rocks are everywhere altered, intricately folded and tilted, and secondary structures have been induced in them. A further result of the intense metamorphism has been the formation of numerous secondary minerals. The structural and age relations of the rocks of the area have not yet been worked out. Most of the rocks are

[1] A Preliminary Report on a Part of the Granites and Gneisses of Georgia: Geol. Survey of Georgia, Bulletin 9—A, 1902; by Thomas L. Watson.

The Granite Rocks of Georgia and Their Relationships, Amer. Geol., 1901, Vol. XXVII, pp. 199-224; by Thomas L. Watson.

geologically old and belong to different periods of formation; some are pre-Cambrian, while others are of later age.

THE ROCK-FORMING MINERALS OF THE CRYSTALLINE AREA

The rocks of the area comprise most of the more common rock-forming minerals and many of the rarer ones. Among the commonest silicates of general occurrence in the Georgia area, are the amphiboles, pyroxenes, micas, epidote, olivine, garnets and feldspars, and a host of others, less abundant, but by no means rare. Many of these are of much importance, in connection with the ore deposits treated in this report; since, from this source, in the manner shown below, the manganese ores of both the Paleozoic and Crystalline areas of the State have been derived.

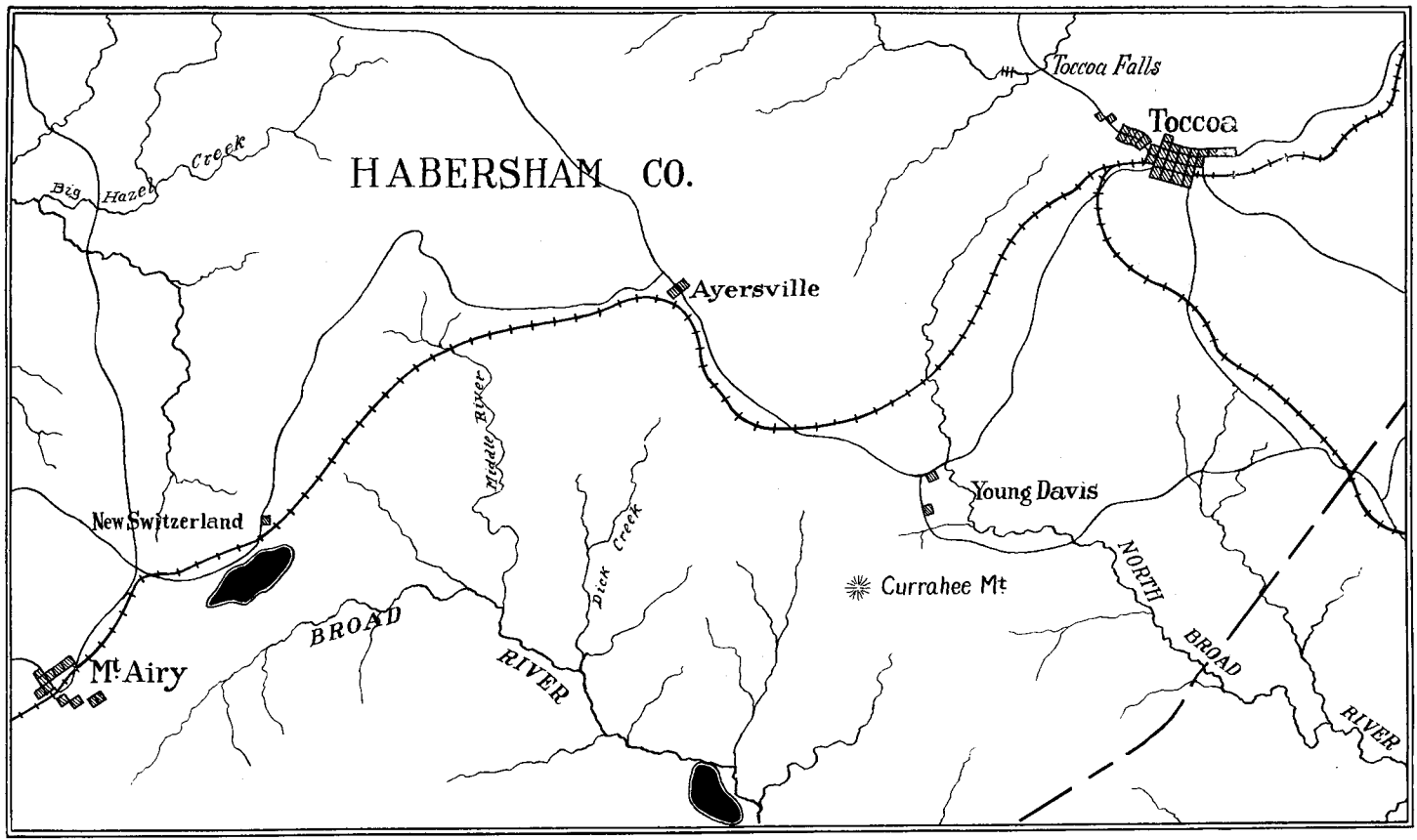
MANGANESE-BEARING MINERALS OF THE CRYSTALLINE AREA

The source of the manganese in the crystalline rocks of the State is chiefly the various silicates containing manganese as one of the base-forming elements. Upon decomposition of the complex silicates, the manganese is either removed in solution in the form of a soluble salt and deposited with the sediment formed elsewhere; or it is retained, in part or whole, in the form of the insoluble oxide, distributed through the residual decay of the original rock, *in situ.*

Numerous manganiferous silicates are distributed through the rocks of the Georgia Crystalline Area, among the commonest of which are certain species belonging to the amphibole, pyroxene, mica, garnet, epidote and olivine groups. A host of other silicates, found in crystalline rocks and containing manganese as one of the base elements, are partly present in the rocks of the Georgia Crystalline Area. Many of these are rare, and if present, they have not yet been identified in the Georgia area.

Besides the silicate of manganese, rhodonite, the element is often found in crystalline rocks combined as the carbonate in the mineral rhodochrosite, and as the oxide in either the free state or with mangnetite and hematite. Both the carbonate and oxide of manganese have been observed by the writer in several localities in the crystalline rocks of Georgia. Rhodochrosite is found in Towns county, two miles west of Hiawassee, associated with the oxides

Fig. 23



Manganese

Map of a Part of Habersham County, Georgia, Showing Distribution of the Manganese Deposits near Mt. Airy, by Thomas L. Watson, Based on the Walhalla Sheet, U. S. Geological Survey.

of manganese and iron in hornblendic rocks of the corundum belt; also in the Ledbetter iron mine, near Cedartown, Polk county. Manganese oxide, in association with small grains and crystals of magnetite, is found in a banded quartzite in Haralson and Paulding counties. The mineral franklinite, an oxide of iron, manganese and zinc, is not known to occur in Georgia; nor is the mineral tephroite, a manganese orthosilicate.

The silicates are much the most abundant minerals in the crystalline rocks of the State and have formed the principal source of the manganese.

DECAY OF THE ROCKS IN THE CRYSTALLINE AREA

All rocks, of whatever nature, undergo a process of decay, designated, under the general term, *weathering,* wherever exposed above sea-level. The process is in part physical and in part chemical. Crystalline rocks, such as compose the Crystalline Area of Georgia, are principally aggregates of complex silicates, which, under normal atmospheric conditions, are unstable. The chemical changes in the minerals convert the complex silicates into simpler and more stable compounds, which are totally different from the original forms. Accompanying such changes, the soluble constituents of the rocks are removed in solution, and the insoluble part is retained as a residual clayey product, which varies in depth, other things being equal, according to the length of time the rocks have been continuously exposed to the atmospheric agents.

It has been shown by recent workers, that the first change involved in rock-decay is the assumption of water — *hydration.* The final stage is that of a completely oxidized product, consisting usually of a ferruginous clay, containing some quartz. Seldom is the change complete; hence, the final residual products invariably contain a greater or less amount of finely divided particles of the undecomposed silicates. In those residual products, in which decomposition appears complete, when washed in water and freed of the clay particles, and treated with very dilute acid, to further remove the staining of soluble compounds, they invariably show, under the microscope, a considerable sprinkling of small grains of the moderately fresh silicates.

The changes, involved in the transition from the fresh to the decayed rock, have been worked out for many different kinds of rock. The general changes include hydration, oxidation, carbonation and solution, whereby the soluble constituents are removed and the insoluble, retained as simpler and different mineral forms from the original. As is shown by the available analyses and calculation of siliceous crystalline rocks, the change is accompanied by a total loss for the entire rock of rarely more than 50 per cent.[1] Some of the granites of the Piedmont area of Georgia have been shown by the writer to have lost in the transition from fresh to decayed rock more than 60 per cent.[2] Of the constituents composing the silicates, the alumina is usually found to be the most refractory, and has, therefore, been retained in the largest amount. This forms a convenient basis for calculating the percentage amounts saved and lost of the other constituents. Under such changes, the base-forming elements combine with carbonic acid and other inorganic acids, to be removed in solution as soluble salts of these acids. A part of the silica, together with the alumina, remains as a residual clayey product, admixed with the free quartz grains of the original rock, in case the rock is quartz-bearing. Both the iron and manganese, when present, are, under certain conditions, removed, either in whole or in part, as soluble salts, and are finally precipitated and deposited along with other sediments. At other times and under different conditions, iron and manganese form insoluble oxides, and are retained in part or whole, and concentrated in the residual clayey product.

The agencies, producing such changes as those described above, have been operative on the rocks of the Crystalline Area of Georgia for an indefinite period, with the result that the fresh rocks are everywhere concealed, at present, under a considerable depth of residual decay. Exposures of the fresh rock are seldom seen, except on the steeper slopes and along some of the stream-courses. The depth of the residual decay is variable, averaging from 50 to 150 feet, in many places.

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[1] Merrill, Geo. P., Rocks, Rock-Weathering and Soils, 1897, p. 234.

[2] A Preliminary Report on a Part of the Granites and Gneisses of Georgia; Geol. Surv. of Ga. Bull. No. 9—A, 1902, pp. 298–348. Bulletin, Geol. Soc. of Amer., 1901, Vol. XII, pp. 93–108.

Manganese Ore Deposits of the Crystalline Area

EXTENT OF THE WORK AND LOCATION OF THE DEPOSITS

More or less prospecting work for manganese ores has been done in a number of counties in the Crystalline Area. The test-work has been sufficient, in most cases, to indicate, that workable deposits of the ore do not exist, although small shipments of the ore have been made from a number of the openings, in different counties. The total production of manganese ore from this area will probably not exceed 50 tons.

The localities, in which prospecting work has been done for manganese, are widely separated, and are scattered over various parts of the area, which bear no apparent geological relationship to each other. The deposits are not associated with any particular type of rock; but they occur in association with several widely different mineralogical types. The occurrence and nature of the deposits are described below, in some detail, under the individual properties. The counties, in which manganese has been worked at all, in the Crystalline Area, are Murray, Fannin, Towns, Cherokee, Haralson, Paulding, Habersham and Hart. A description by counties follows below. In Haralson and Paulding counties, the ore occurs along the line separating the two counties, in the vicinity of Draketown; and the deposits are described separately, not by counties, but under the Draketown district.

NATURE AND MODE OF OCCURRENCE OF THE MANGANESE ORES

The manganese deposits of the Crystalline Area are of but little, if any, commercial importance; but they have considerable geological interest. The lithologic associations and mode of occurrence of the manganese ores are different from those of the Paleozoic Group. The ore is usually massive and often fine granular, admixed or otherwise closely associated with iron, and, less often, of the gravel and larger concretionary-nodular forms, so characteristic of the Cartersville district and other of the Paleozoic Group deposits. Of the former occurrence, the locality to the northeast of Cohutta Springs in Murray county, and that of the Draketown district in Haralson

and Paulding counties, are the most typical. In the northeast part of Murray county, near the Tennessee line, and from five to six miles northeast of Cohutta Springs, the manganese exists as small nests or pockets, in extensive beds of iron ore, in the Ocoee (pre-Cambrian (?)) quartzites and slates. In its purest form, the manganese is not entirely free from iron, and much of it is a manganiferous iron ore, of apparently homogeneous composition.

The ore of the Draketown district, in Haralson and Paulding counties, occurs as massive and finely divided manganese oxide, in a thinly banded sandstone or quartzite, intercalated with mica-schist. The siliceous rock is heavily charged with small grains and crystals of manganiferous magnetite and separate grains of manganese oxide; and, in places, it is pyritiferous. The manganese is mostly concentrated along the contact between the quartzite and the schist; but it is contained mostly in the quartzite, as massive ore, carrying usually much iron, which, at times, almost totally replaces the manganese. Between the two extremes of a manganese ore containing a little iron and an iron ore with a little manganese, all grades of admixture of the two metallic oxides occur.

The nodular type of ore, similar to that of the Cartersville district, is perhaps best developed in the manganese deposits occurring near the southern limits of the town of Blue Ridge in Fannin county. Here, the manganese is found in the residual clays derived from the decay of mica-schist, near the margin of a narrow band of jaspery quartzite, which cuts the schist in an approximately north-south direction. The manganese is distributed through the clay as gravel, reniform nodules and larger masses, in nests or small pockets and stringers, the ore of which contains much siliceous impurity. At this locality, the manganese is also in intimate relation with iron ore, much of which has been mined and shipped.

At other localities in the Crystalline Area, manganese is found in massive and nodular forms, and as a black, clayey mixture of finely divided manganese oxide, in the residual clays derived from the decay of hornblende and mica-schists. The mica-schist is often garnetiferous.

The above occurrences of manganese in the crystalline rocks indicate, (1) a concentration of the ore along and near the contact

between certain formations; and (2) accumulation of the ore in the residual clays derived from the decay of various siliceous crystalline rocks. In mode of occurrence and formation, and in the character of the ores classed under the second heading, a close resemblance is indicated to the deposits of the Paleozoic Group.

Beyond the limits of the counties named above, it is probable, that similar occurrences of manganese ore may also be found in many of the other counties in the Crystalline Area. Some manganese stain, in the residual clays derived from the decay of the underlying rocks, exists in almost every county in this area of the State. In Lumpkin county, associated with a gold-bearing quartz vein in the Bast mine near Dahlonega, pyrolusite, in botryoidal masses, two or three inches thick, and several feet in length, was secured in 1896 by the State Geologist, Prof. W. S. Yeates, for use as specimens for the State Museum.

THE MINERALOGICAL FORMS OF THE ORES

The manganese ores of the Crystalline Area occur as oxides of the metal, in both the massive and nodular form; and, in some of the localities, the ore is partly crystalline. Mineralogically, the ores are generally impure, from the invariable presence of considerable quartz and other siliceous material, and, usually, much admixed iron oxide. But, for commercial purposes, the ores could be made of value, if they were found in sufficient quantities. In most cases, the ore is probably a mixture of several of the oxides of manganese; but the purer forms, in some of the localities, indicate, from the physical properties, the mineral pyrolusite. Sufficient chemical work has not yet been done to determine which oxides of the metal are present. A small amount of the mineral rhodochrosite, a manganese carbonate, was found lining the cavities of some of the more porous masses of impure manganese and manganiferous iron ores in Towns county, several miles west of the town of Hiawassee.

ORIGIN OF THE MANGANESE ORES

The nature and mode of occurrence of the manganese deposits of the Crystalline Area have been described in considerable detail

in this chapter, both in the preceding pages and under the individual properties to follow. It only becomes necessary here to briefly summarize the leading facts, and indicate the general mode of the ore formation.

The ore occurs in the form of the oxide, embedded in the residual clays, and frequently concentrated along or near the contact of certain formations. It is usually associated, and at times admixed, with greater or less amounts of iron oxide; and it always contains much silica. The oxides of the metal are not always found in association with the silicates, from which they have been derived; although an examination of the ore-bearing clays reveal small fragments of undecomposed silicates, in quantity proportional to the stage of decay, whether complete or partially complete.

At a number of openings made for manganese in different parts of the Crystalline Area, opportunity was afforded for tracing the formation of manganese oxides from several of the manganese-bearing species of silicates. Of these, a manganiferous garnet and mica showed the formation of the oxide from the original silicate in a partially and completed stage of decomposition. In each case, the early stage was indicated by the original mineral being irregularly coated and spotted from decay, by a mixture of the oxides of manganese and iron. The final stage showed the almost complete destruction of the original mineral, and its place filled by the black amorphous oxides of manganese and iron. More or less stain from the oxide had extended beyond the limits of the original manganese-bearing silicate, discoloring the enclosing clays.

The source of the manganese in the Crystalline Area has been mostly, if not entirely, from the various manganese-bearing species of silicates, which enter largely into the composition of most of the rocks. By the decomposition of the minerals composing these rocks, the base-forming elements either form soluble salts of inorganic and organic acids, promoting the decay, and are removed in solution; or else, the whole or a part of some of the base elements are converted into insoluble oxides and are retained, *in situ,* in the residual clays. In either case, the process may result in the removal, by solution, of only a part of certain ones of the base elements (iron and manganese) in the form of soluble salts; while the remainder

of the same elements is retained as insoluble oxides in the residual decay. That both reactions are common in the surface zone of oxidation, is proved by recent work in rock-decay, and also by the occurrence of certain ore accumulations, the genesis of which would be difficult with any other explanation.

Recent investigations in rock-weathering show, that iron is frequently retained in the residual clays, in amounts larger than that of any other constituent, in proportion to the percentage amount present in the fresh rock. A loss, however, by removal in solution, in the form of a soluble salt, on decay of the rock is, perhaps, more often shown in the iron. So far as studies have been conducted, the iron is not entirely removed in any case; but a part of it remains in the form of the insoluble oxide. A like tendency is indicated for manganese, when present in those rocks, so far investigated.

Upon subsequent chemical and physical changes, the manganese is further concentrated in the residual clays; and the accumulations of the oxide are sometimes in quantities sufficiently large to be of commercial value.

Some of the manganese deposits of the Crystalline Area indicate, that the ore has been leached from the surrounding rocks, upon decay, and concentrated in the clays along the contact zones of certain formations. In only one locality in the Crystalline Area, namely, the Draketown district of Haralson and Paulding counties, has manganese been found in the form of the oxide, in place, in the original rocks. The manganese exists here, partly as the free oxide in a banded sandstone or quartzite, and partly as a manganese-bearing magnetite, which forms a considerable percentage of the rock, in places. Concentration of the manganese along with iron has taken place, near the margin of the quartzite in contact with mica-schist, in quantities sufficient to yield a small amount of workable ore.

The decay of the crystalline rocks of Georgia has been in progress from the earliest times; and the rocks are, at present, everywhere covered by a considerable thickness of the residual decay. Accompanying the process of decomposition, both the removal and retention of manganese, in more localized form, have been promoted in

places. The process is still in progress, and, accompanying it, the accumulation of manganese wherever the conditions are favorable.

Briefly stated then, the manganese ores of the Crystalline Area of Georgia represent the secondary accumulations of the insoluble oxides of the metal, supplied from the manganese-bearing silicates, on decomposition, and subsequently concentrated and localized in the residual clays, derived from the decay of the underlying siliceous crystalline rocks. In places, accumulation of the oxides has progressed along and near contact zones in the rocks; in other places, concentration has been in the clays and removed from contacts.

Lumpkin County

As yet, no workable deposits of manganese have been found in Lumpkin county. The extensive excavations worked for gold, in and around Dahlonega, the county-seat, show the average, in depth, of the decayed rock to be several hundred feet, in places. The residual clays have been derived from the decay of metamorphic igneous and sedimentary rocks. The rocks are everywhere profoundly altered, as is shown in the fresh exposures and outcrops; and they bear at present only slight resemblance to the original rock from which they were derived, making it very difficult to differentiate original sedimentary from original igneous rocks. The principal rocks are schists of the hornblendic, chloritic, micaceous and quartzose types.[1] Garnet, as a secondary mineral, is usually present, to some extent, in all the rocks mentioned.

The ferro-magnesian minerals present in the different rocks are manganese-bearing to some extent. On decay of the rocks, the manganese, converted into the form of the oxide, has been largely retained, and is concentrated in places in the residual clays. The planes of fracture, jointing and schistosity of the fresh and hard rocks, are usually well preserved in the residual decay of the rocks; and it is along these planes in the clays, that the manganese is mainly concentrated. This coating and coloring of the clays by manganese oxide is considerable in places. Beautiful specimens of botryoidal manganese oxide of great purity were observed in

[1] Watson, Thomas L., A Preliminary Petrographic Report on Some Metamorphic Rocks in and Around Dahlonega, Lumpkin County, Georgia; Geol. Surv. of Ga., Bull. 4—A, 1898, pp. 320-330.

places embedded in the residual clays. To this extent, manganese oxide is generally present throughout the decayed-rock covering of the region; but, as yet, no workable deposits are met with.

Probable workable deposits of iron ore, magnetite and limonite, occur at several localities in the county, and some prospecting work has been done, with a view to mining. In some instances, the iron ores have been mistaken by some for manganese.

HABERSHAM COUNTY

The occurrence of manganese in the Crystalline Area of Georgia, near the town of Mt. Airy, in Habersham county, was mentioned by Dr. Penrose in 1891.[1] Some prospecting work for manganese has been done in two localities in the county; namely, two miles northeast of Mt. Airy, on Mr. Fort's property, and again, about eight miles east of Mt. Airy on Broad river, near Currahee mountain, on the Edge property. The indications, near Currahee mountain on the Edge place, are very scant, amounting to no more than a slight staining of the decayed rock, in which excavations were worked many years ago for gold. So far as developments indicate, no workable deposits of manganese occur in the county.

The prevailing rock in the Mt. Airy district is a mica-schist, highly quartzitic at times, cut by stringers and large veins of quartz and by dikes of basic eruptive rocks. About a quarter of a mile south of the depot at Mt. Airy, in the cut of the Southern Railway, the decayed products of several basic dikes are exposed. The decomposition product is a deep red and yellowish brown plastic clay, such as results from the decay of diorite. The contact at this point between the decay of the mica-schist and that of the diorite is sharp and well defined. The rocks in this area are mantled with a deep covering of residual decay, and exposures of the fresh rock are seldom seen.

The topography of the Mt. Airy district is shown on the accompanying map,[2] which is sufficiently explanatory.

THE JOHN P. FORT PROPERTY. — This property, *lot 177, 10th district,* is located two miles northeast of the town of Mt. Airy, im-

[1] Geological Survey of Arkansas, Ann. Report for 1890, Vol. I, p. 424.

[2] See map Fig. 23.

mediately along the main line of the Southern Railway, on the east side. A number of openings were made for manganese, two years ago, grouped about three centres in different parts of the lot, within less than half-a-mile apart.

The southeast openings have been made in a much crushed and fractured quartz vein, three feet wide, cutting mica-schist. The angular quartz fragments, which are usually in place, have been cemented by manganese oxide from percolating waters, forming, in places, a manganiferous quartz breccia. The coating of manganese oxide along some of the fractures is as much as an eighth of an inch in thickness; but the bulk of the penetrating manganese is of knife-edge thickness. The quartz is of the white, hard, flinty kind; and in most cases the quantity of manganese cement is too thin to bind the fragments together. One large and well timbered shaft has been opened to a depth of 60 feet on the vein. No workable manganese has, of course, been found.

The remaining two groups of openings on the lot, respectively northeast and east of the quartz-vein pits, are made in the residual decay derived from the mica-schist, which is cut by tiny quartz stringers and veinlets, in a nearly vertical position. The original structure (schistose planes) of the fresh rock is well preserved in the decay, and usually dips steeply toward the southeast. Quite a concentration of low-grade siliceous manganese ore is scattered, in loose fragments, over the surface, and is exposed in place in the northeast group of pits. The manganese at these openings is distinctly a secondary accumulation, derived from the mica, and concentrated in the siliceous clays of the schist. The change from the partially altered mica, showing some manganese staining, to complete decomposition, where concentration of the ore takes place, is beautifully shown in several of the openings. The quartz fragments of the stringers and veinlets are usually coated with the manganese oxide. The concentration of the ore is mostly along the schistose planes, and at times resembles replacement deposits.

In one of the northeast openings, the ore has a thickness of several feet; and it bears close resemblance to a residual blanket ore-deposit. It is massive; and it occurs at a depth of less than three feet below the surface. The ore is formed of the crystalline steel-

gray manganese, cementing together small grains of quartz, which are included in sufficient quantity to raise the percentage of silica in the ore, too high for profitable working. A little gravel or pellet ore was observed at several of the northeast openings.

Through the kindness of the owner, Mr. John P. Fort, I am able to give, below, the results on analysis of specimens of the ore, made by Mr. W. J. Rattle, of Cleveland, Ohio, May 30th, 1899.

	Per Cent.
Metallic manganese	54.16
Metallic iron	1.32
Silica	3.73
Phosphorus	0.092

Mr. Fort informed the writer that a fraction of one carload of this ore had been shipped without washing or cleaning.

Similar surface indications of manganese occur at a number of places over the county, in the vicinity of Mt. Airy.

THE ALEX EDGE PROPERTY. — Six miles southwest of Toccoa, on the south side of Broad river, and near Currahee mountain, considerable work was done, prospecting for gold before the Civil War. Some of the openings are reported to have yielded some manganese. The openings are almost entirely obscured at present, from falling in, and nothing of a metalliferous character is visible.

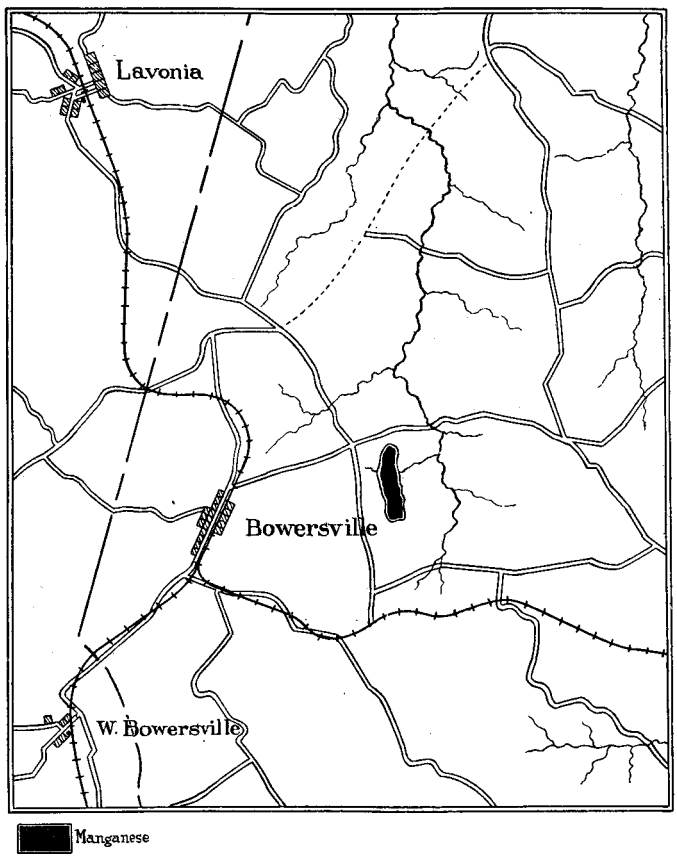
Within the past two years, several small pits have been dug along the branch for manganese. The largest one of these is a long shallow cut, dug on a knoll, just above the branch, in the decayed mica-schist, which is more or less feldspathic in places, and is interbedded with some quartzite. A few small and impure fragments of admixed iron and manganese oxides were found on the dump. The residual clay, derived from the schist, is slightly stained in places by manganese and iron oxides, which sometimes penetrate and partially fill the cracks in the clays and the partially decomposed schists. No workable manganese occurs.

HART COUNTY

Hart county is located within the extreme southeastern limits of the Piedmont plateau in Georgia. Its topography is the character-

istic low-hilly type of the Piedmont plain, and is well exemplified on the accompanying map. The streams drain east and southeastward into the Tugalo river; and, for the most part, they occupy moderately broad and shallow valleys, usually less than 200 feet below the general level of the average hill tops. The prevailing rock is mica-schist; similar to that described in Habersham county, page 169 of this report; and it is deeply covered by a siliceous residual clay, derived from the decay of the schist.

FIG. 24



Map of the Bowersville Area, Hart County, Georgia, showing the Distribution of the Manganese Deposits, by Thomas L. Watson. Based on the Carnesville Sheet, U. S. Geological Survey.

Manganese has been worked at only one locality in the county, namely, one and a half miles east of Bowersville. Similar surface indications have been observed, to the north and south of Bowersville, and to the west, near Carnesville, in Franklin county. No developments have been made, where these indications appear. It is, therefore, impossible to say whether workable deposits exist at these points. The indications, however, are no better than at other points in the Crystalline Area, where prospecting work has indicated the general absence of workable ore. The total shipment of manganese ore from Hart county, which represents the single working, to the east of Bowersville, and amounts to only a few carloads, is as large as that for any county within the Crystalline Area of the State.

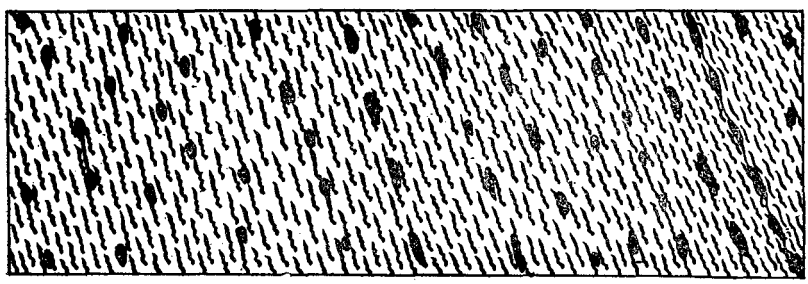
THE BROWN PROPERTY. — One and a half miles east of Bowersville, on the J. R. Brown place, a cut about 120 feet long, from 20 to 25 feet wide, and averaging 10 feet in depth, was worked for manganese, some half-dozen years ago. Several carloads of the ore are reported to have been shipped.

The ore occurs, as a massive deposit, in the deep-red residual clay, derived from the decay of the mica-schist. It will average from three to six feet in thickness, and it lies several feet below the surface. So far as could be determined from the character of the exposure, the ore is in the form of large masses, varying from one to several yards in diameter, massed together as an irregular lens or layer. Along the south and west walls of the widest part of the cut, some pellet or shot ore occurs. These usually show the layer or concentric structure, and are composed of soft, amorphous material. The massive ore is from dark steel-gray to blue in color; more or less cellular or porous; and contains a large percentage of silica, in the form of very small, pure quartz grains, somewhat uniformly disseminated through the ore in large quantity. The quartz granules in the ore have the general appearance of having been deposited from solution. They frequently appear as minute areas composed of the finer saccharoidal quartz particles.

Along the east wall of the cut, the origin of the manganese and its mode of accumulation are well shown. Here, the schistosity planes of the original schist are entirely preserved in the residual decay

of the rock, having a nearly vertical dip. The mica of the original schist is apparently manganese-bearing. On decomposition, the liberated manganese oxide is retained, in part at least, and is concentrated along the planes of schistosity. Further decay shows the removal of the mica, and, in its place, the accumulation of the ore, enclosing the insoluble quartz grains of the original schist. Garnet is entirely absent as a constituent of the rock in this locality, and no trace of any manganese-bearing mineral is present, except the mica. Figure 20 below shows the occurrence of the ore in this opening.

FIG. 25.



Section through the Manganese-bearing Schists near Bowersville, Hart County, Georgia, Showing Distribution of Small Manganese Areas, Represented by the Black Dots.
Horizontal Scale : 3 inches=10 feet. Vertical Scale : 1 inch=4 feet.

The manganese ore on the Brown property appears to be practically free from iron; although limonite is found in the form of loose fragments, scattered over the surface about a quarter of a mile north of Bowersville; and it doubtless occurs at other places near the manganese.

A large quantity of manganese ore is in sight, at the opening east of Bowersville; but the general distribution of a large quantity of small quartz grains through the ore considerably lessens its value.

OTHER MANGANESE OCCURRENCES IN HART COUNTY. — Several small test-pits have been dug on the Allen place, a short distance to the southwest of the Brown property. Surface indications of manganese, in the nature of small loose fragments, appear to a limited extent, in several places, in the vicinity of Cross-Roads church, four

miles northeast of Bowersville, and in Franklin county near Carnesville. In fact, slight surface indications of manganese are to be generally seen over parts of both Hart and Franklin counties; but the ore does not seem to be sufficiently concentrated to be workable.

Murray County

Murray, one of the extreme northwest counties of the State, borders Tennessee on the south. The Cartersville thrust-fault enters the State from Tennessee, near the middle of the east-west north-boundary of Murray county; and it continues southward through the county, passing near and to the west of Cohutta Springs. As regards the geology and topography, this breakage line divides the county into two unlike east and west parts.

The rocks on the west side of the fault-line are limestones and shales, of the Paleozoic series. These comprise more than half the total area of the county. The succession of formations is in descending order: —

Chickamauga limestone and shale	Silurian
Knox dolomite	
Conasauga shale	Cambrian

The Paleozoic area, or west half of the county, presents nearly a plain surface, the general elevation of which is about 750 feet above mean sea-level; and it is strongly contrasted with the metamorphic crystalline area of the east half. The larger streams have entrenched themselves chiefly in the soft Conasauga shales, which mark the larger valley positions; and, for this reason, the shale area has a general elevation somewhat below that of the more resistant limestones.

The area to the east of the fault-line, or the east half of the county, is composed of a diversity of crystalline metamorphic rocks of doubtful age. That part of the metamorphic area, to the east of Cohutta Springs and extending northward into Tennessee, is composed principally of interbedded quartzite and fine-grained dark-colored slates. The quartzite is dark-gray in color, usually fine-grained and compact in texture, with a pronounced conglomeratic facies in places, and is the most extensive rock of the area. Thin sec-

tions made from specimens of the quartzite, collected along the wagon road between Cohutta Springs and North Cohutta Springs, showed, on microscopic examination, rounded and sub-angular grains of crystalline quartz and a sparse scattering of small grains of a striated feldspar. The quartz is considerably clouded by inclusions of black granules and dust-like particles of supposed iron oxide, and possibly some manganese oxide. At this point, the rock is shaly or slaty in character, and contains considerable pyrite at times. The associated slates are usually dark in color and fine-grained, highly quartzitic in places, and carry some pyrite. This description is especially characteristic of the outcrops around Cohutta Springs. The rocks are sharply and complexly folded; and they presumably belong to the Ocoee group, probably pre-Cambrian. They bear a close resemblance to a similar series of rocks occurring on the east side of, and in contact, with the same fault line to the south in Bartow county, a short distance to the east of Cartersville. This area in the Cartersville district is classed by the United States Geological Survey, as the Ocoee series, pre-Cambrian in age.

The topography of the metamorphic area of Murray county is exceedingly rough and broken, consisting of high and steeply sloping ridges and spurs of irregular outline, which enclose correspondingly narrow and deep valleys, usually carrying swift flowing streams. The general elevation of the ridge-tops in the extreme northern part of the area is about 2,000 feet; but, further south and to the east, extreme elevations of 3,000 and 4,000 feet are not uncommon. This area is in marked contrast with the adjacent lowland of Paleozoic rocks on the west.

Topographically, the transition from the lowland of Paleozoic rocks on the west, to the crystalline metamorphics on the east, is sharp and abrupt; and, on topographic grounds alone, one would naturally infer a fault separating the two areas. The western margin of the crystalline area is irregular and much dissected by erosion; but it rises as a more or less broken, but steep escarpment, several hundred feet in places, above the underthrust Paleozoic sediments.

The position of the fault was observed at several places, marked by a breccia-zone of the altered rock, several feet in width, derived

RESIDUAL CHERT AND CLAY RESULTING FROM THE WEATHERING OF THE KNOX DOLOMITE, IN A CUT ON THE CENTRAL OF GEORGIA RAILWAY, NEAR SUMMERVILLE, CHATTOOGA COUNTY, GEORGIA.

from the unlike rocks on the two sides of the thrust-plane. The exact fault-position is not easily made out, in places where the slates and shales of the metamorphic and Paleozoic rocks are in contact.

The sandstone ridges, to the north of Cohutta Springs and in the northern part of the metamorphic area in Murray county, contain large deposits of brown iron ore, enclosing, at times, small pockets of manganese, and, in places, grading into manganiferous iron ore. During the summer of 1902, a railroad was being graded and built from Dalton, Georgia, to pass through or near this area to a point in Tennessee. This, when completed, will cause rapid development of the mineral resources of the county.

Description of the Properties

Paleozoic series

Manganese staining is seen in the residual clays derived from the underlying rocks of the Paleozoic group in places, in the west half of the county; but no indications of workable deposits of manganese were observed.

Metamorphic area

The only occurrence of manganese in the county, which might prove at all workable, is in the metamorphic area from four to six miles north of Cohutta Springs, near the Tennessee line. So far as developments extend in this locality, the quantity of manganese is exceedingly limited and would only warrant working in connection with the iron ore, but not as separate deposits. It is probable, that, in working the iron deposits, occasional small shipments from local accumulations of the manganese would be profitable.

The White Lot. — *Lot 276, 27th district,* is located near the top of a high and steeply sloping quartzite ridge. Two small pits have been dug in the residual decay in different places on the lot, exposing a few fragments of manganese breccia ore. The ore consists of small broken fragments of the quartzite, cemented together by crystallized manganese oxide. The manganese oxide as cement constitutes only a small percentage of the breccia mass. At the time of the writer's examination of the property, the quantity of breccia ore was exceedingly small, and that which was shown was in no sense workable. Some manganiferous iron ore also occurs on the

lot; but development was lacking, and no statement can be made as to the quantity.

THE HEAD LOTS. — Half-a-mile north and east of the White lot, on *lots 266 and 275, 27th district,* occurs what appears to be, from surface indications, rather large deposits of manganiferous iron ore. No prospect openings have been made, and the ore is strewn over the surface of the quartzite ridge as loose fragments.

THE POWELL LOTS. — About one and a half miles northeast of the Head lots, and within less than a mile of the Tennessee line, on *lots 236 and 237, 27th district,* owned by Mr. F. A. Powell, of Atlanta, Georgia, several small openings have been made in the quartzite decay on the high ridges, exposing small and limited nests and pockets of manganese, intimately associated with the deposits of limonite.

One shaft has been sunk to a depth of 32 feet, and a second opening, seventeen feet deep, has been dug, with smaller test-pits opened in several places. The openings are made in a siliceous red clay, the depth of which is variable, being thinnest nearest the ridge tops and deepest nearest the basal slopes and in the valley-bottoms. The quartzite outcrops as reefs and large broken masses along the crests of the ridges, in many places; and the surface of the ridge-slopes are scattered with the loose fragments of the quartzite, of all sizes. When broken or chipped with the hammer, the exposed rock is often highly impregnated with iron oxide, and to some extent with manganese oxide. These discolor the rock a dark ferruginous color, the intensity of which varies according to the amount of the oxides present. From this, the source of the ore is plainly from the quartzite, subsequently concentrated in the residual decay on weathering.

The manganese is distributed, in part, through the red clays as nodules, and as separate small pockets, in the brown iron ore. Some breccia ores occur, and in one of the smaller openings on the ridge-summit, the hard and moderately fresh quartzite, exposed at a depth of several feet, was fractured, and the cracks filled with the oxide of manganese. One of the manganese veins in the rock measured several inches in width. The indications are, that the manganese is present in small and limited quantities, though usually of good quality, and that it is always intimately associated with the more extensive deposits of brown iron ore.

The following analyses of specimens of the manganese and iron ores from this property, made by Mr. William H. Bowron in 1896, were kindly furnished the Survey by Mr. F. A. Powell: —

	Iron Ore	Manganese Ore
Metallic Iron	54.54	0.84
Metallic Manganese	5.91	54.36
Silica	4.20	1.21
Alumina	0.38	trace
Phosphorus	0.45	0.76
Sulphur	0.92	none
Water (Combined)	18 62	4.86

Fannin County

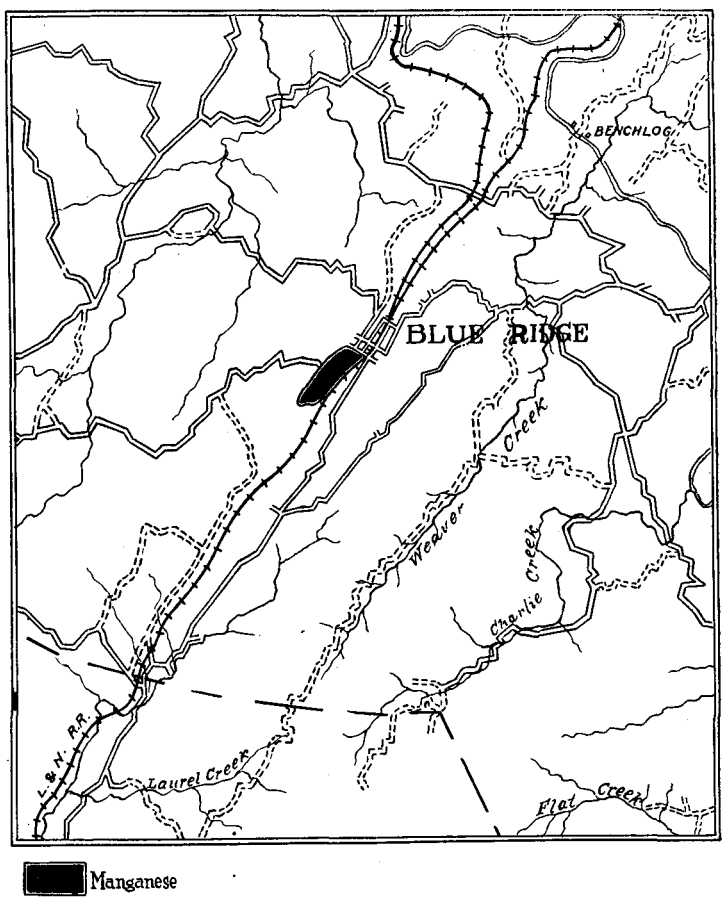
Manganese has been worked to a limited extent, at only two places in Fannin county, namely, within the southern limits of the town of Blue Ridge, and ten miles northeast of Blue Ridge, near the State-line, one and a half miles south of Culbertson, North Carolina. At Blue Ridge, the mining was for iron ore, and all the shipments of ore were limonite. To the south of Culbertson, in the northeast corner of the county, considerable money was spent several years ago in prospecting for manganese; but, as yet, less than three tons of the ore have been shipped.

The Blue Ridge Property. — Some half-dozen openings were made within and near the southern limits of the town of Blue Ridge two years ago, within less than one hundred yards of the Atlanta, Knoxville and Northern railroad, on the McKinney property. The openings have a north 30° east alignment, and the extreme northeast-southwest openings are about a quarter of a mile distant from each other. The openings are in the nature of open-cuts, the two northernmost being the largest and the ones from which most of the ore was mined. The mining was for iron ore, large shipments of which are reported to have been made. No reported shipments of manganese were obtained.

Black oxide of manganese, of the earthy, and the concretionary-nodular types, is exposed in all the openings, in close relation with the limonite. The manganese ore closely resembles that of the Cartersville district in Bartow county, described on pages 32-99 of this report. The ore is usually crystalline, and occurs in the residual

clays, in the nature of gravel or pellets and concretionary nodules of various sizes, the largest of which will measure from four to six inches in diameter. The manganese-bearing clay appears to be of very limited lateral extent, comprising a zone, usually not exceeding 18 or 20 feet wide, and extending in a north 30° east course. The north-south limits of the ore-bearing belt have not been determined. In the northernmost openings, the nodular and gravel ore

FIG. 26



Map of the Blue Ridge Area, Fannin County, Georgia, showing the Distribution of the Manganese Deposits, by Thomas L. Watson. Based on the Ellijay Topographic Sheet, U. S. Geological Survey.

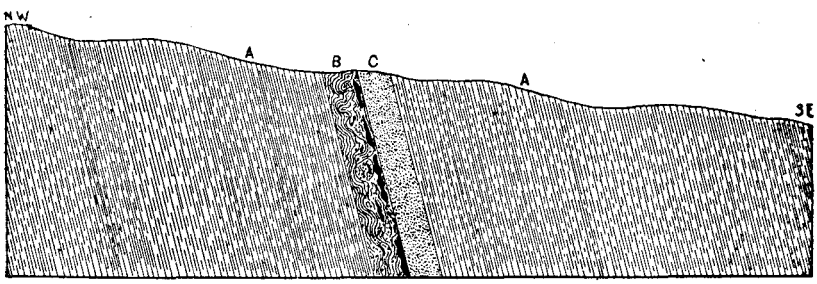
predominates; while the earthy form of manganese oxide comprises the ore mainly exposed in the south cuts.

The larger masses are botryoidal in shape, and usually enclose a considerable proportion of free quartz grains.

The rock is a mica-schist, containing, in places, much quartz, and grading to the east and west into a quartz-schist, which carries a minimum of mica. The schistosity planes dip steeply toward the southeast, usually nearly vertical. Immediately on the east side, and in contact with the ore-bearing clay, is a narrow zone of jaspery quartz, several feet in width, and highly impregnated with iron oxide, and to some extent in places, with manganese oxide. It is not infrequently cellular, with drusy surfaces lining the cavities; but, usually, it is dense and compact in texture. In the north cut, it is replaced almost entirely by a banded quartzite. This vein of jaspery quartz is traced, for a considerable distance north of the northernmost cut, through the town of Blue Ridge.

Purple, yellow and lighter-colored clays compose the residual mica-schist decay. From its nature of occurrence and its relation to the surrounding rocks, the manganese indicates accumulation in the residual schist-clays, near and along the contact with the jaspery quartz vein. Figure 27 shows the mode of occurrence of the ore, and its relations to the surrounding rocks.

FIG. 27



Section through the Blue Ridge Mine, Fannin County, Georgia, Showing the Mode of Occurrence of the Manganese and Iron Ores. A. Partially Decayed Mica-schist Grading into Quartz-schist, in Places. B. Manganese and Iron Oxides Distributed through the Decay of the Mica-schist. The Black Dots and Areas Represent the Ores. C. Jasper.

THE POLK PATTERSON PROPERTY. — One and a half miles south

of Culbertson, near the Georgia-North Carolina State-line, in Fannin county, Georgia, a considerable sum of money has been spent in prospecting for manganese ores on the Polk Patterson property. Colonel J. H. Moore, of Dahlonega, Georgia, who is the present owner of the property, informed the writer in August, 1902, that not more than three tons of manganese ore had been shipped, and that work would probably be again resumed in the fall of 1902.

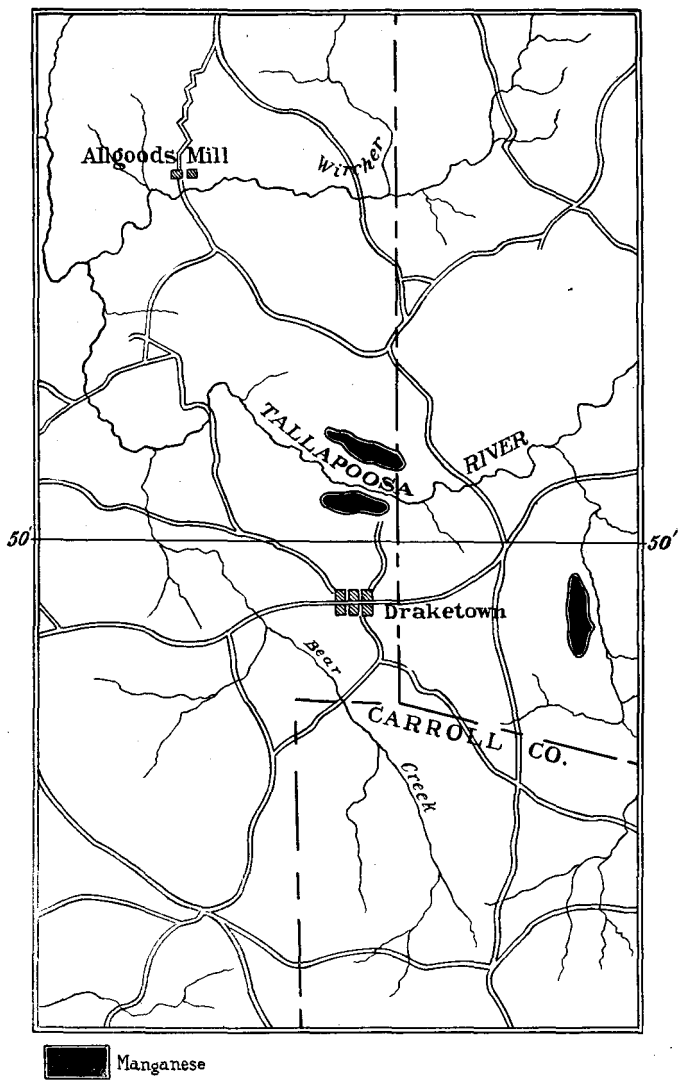
Haralson and Paulding Counties

THE DRAKETOWN DISTRICT

With the exception of one or two occurrences in each county, the manganese deposits of Haralson and Paulding counties are grouped together, along the line separating the two counties, in the vicinity of Draketown. The rocks are the same in the district for the two counties, and the nature and mode of occurrence of the manganese and its relation to the surrounding rocks are identical. For these reasons, the deposits are best treated, not separately, under the name of each county, but together as one area, under the name Draketown district. Some mining has been done for manganese in both counties, near the line separating them, and a small quantity of the ore is reported to have been shipped.

The occurrence of manganese ore in the Draketown district differs from that in other localities, studied in the State. The ore does not occur as gravel and concretionary nodules in residual clays, as is shown in the various areas, already described in other parts of the State; but it is found in massive form along the contact of banded quartzite and mica-schist. The quartzite carries a large percentage of magnetite as small grains and crystals, arranged along bands of varying thickness and purity. The quartzite is hard and firm rock, and the manganese is found impregnating it, to a considerable extent, near the contact with the schist, in much the manner of a replacement. Carefully collected specimens of the quartzite, taken at and away from the contact, at all the openings in the two counties, showed, when tested in the laboratory, the presence of considerable manganese oxide. The magnetite was readily separated from the rock and other particles by means of the magnet,

FIG. 28



Map of the Draketown District, Georgia, showing the Distribution of the Manganese Deposits, by Thomas L. Watson. Based on the Tallapoosa Topographic Sheet, U. S. Geological Survey.

after crushing. Upon further testing the isolated magnetite, manganese oxide was found to be present in more than traces, in every case.

Further details, regarding the occurrence and character of the manganese ore, are best brought out in the descriptions of the individual properties, below. After a careful examination of the Draketown manganese area, the writer is convinced, that workable deposits of manganese ore do not occur. More or less money has been spent in exploiting the supposed workable deposits of the ore, in both Haralson and Paulding counties, with the result, in each case, that the manganese is not sufficiently concentrated, nor free enough from impurities, to warrant profitable working.

DESCRIPTION OF PROPERTIES IN THE DRAKETOWN DISTRICT

THE DRAKETOWN MINING COMPANY. — One and a half miles north of Draketown, in Haralson county, the Draketown Mining Company did considerable prospecting work for manganese, about the year 1897, on *lot 981, 19th district*. Openings were made at two places on the lot, about 500 feet apart, in approximately a northwest-southeast alignment. Several shafts were sunk, the deepest of which is reported to have reached 100 feet in depth. A number of cars of the ore are said to have been shipped from the lot.

The residual decay is quite deep over all parts of the lot, and the openings had so caved in on the sides, at the time of the writer's examination, that the exact relations were difficult to make out. So far as it was possible to determine the conditions, the manganese ore apparently occupies the position of a contact deposit, along the margin of a banded quartzite, carrying a variable quantity of magnetite grains. The width of the quartzite could not be determined for the reasons given above. In places, the rock strikingly resembles a quartz vein, which it might have proved to be, if the necessary exposures of the rock occurred for inspection. The ore is massive, and at times partly crystalline; and it is intimately admixed with a large proportion of iron oxide, consisting of both hematite and magnetite. The quartzite rock is highly impregnated with a black oxide, which, upon testing in the laboratory, proves to be mostly manganese admixed with some magnetite. When so

impregnated, the rock is entirely black in color, from the preponderance of the black oxides. All gradations occur between the highly charged manganese and iron oxide rock, of black color, and the ore-free rock of the usual light, nearly white color. The rock is not infrequently porous, or spongy, and the small cavities are partially, or entirely, filled with the powdery form of manganese oxide. Several limonite pseudomorphs after pyrite were found in the rock at one of the openings.

THE GRIFFITH PROPERTY. — Three miles north of Draketown, on the Griffith tract, in the *19th district,* Haralson county, a little prospecting work for manganese has been done; but no ore has been shipped. The conditions are similar to those described on the Draketown Mining Company's property, above.

THE WESTBROOK PROPERTY. — A show of manganese occurs on several lots owned by Mr. J. C. Westbrook, namely, *995 and 997, 20th district,* Haralson county, from a mile to a mile and a half northwest of the Draketown Mining Company's tract.

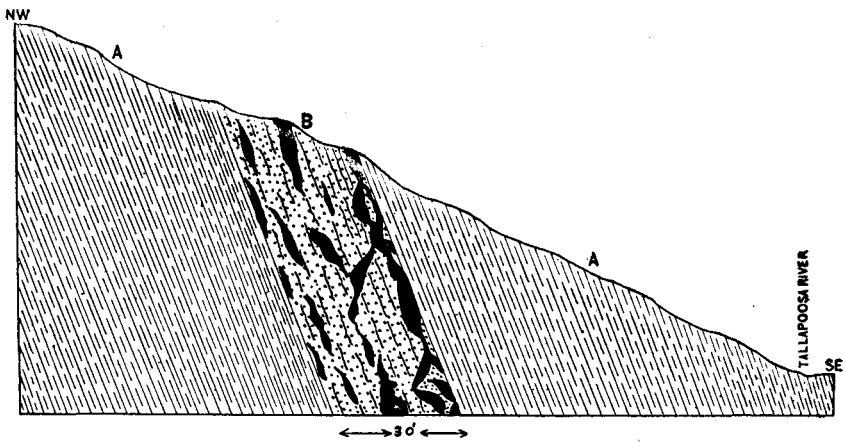
On *lot 995,* one cut, 50 feet long and 10 feet deep, has been opened on the east slope of a ridge, rising from 100 to 150 feet above the adjacent valley-bottom, exposing some manganese admixed with magnetite and manganiferous iron ore. The ridge is composed of banded quartzite and mica-schist. Large reefs and broken masses of the quartzite, of unusual size, are exposed over the ridge-slope.

The ore is confined to the banded quartzite, which is cut by quartzite veins or stringers; and it comprises a mixture of granular magnetite, manganiferous iron oxide and partially crystallized massive manganese oxide. The magnetite occurs as small grains and crystals; and, on crushing the rock, the magnetite is readily separated by the magnet. Specimens of the magnetite-quartzite, tested in the laboratory, showed the presence of much manganese oxide. Other specimens of the rock, composed almost entirely of ore, of the spongy type, and from steel-gray to black in color, indicated, when tested in the laboratory, only a small amount of magnetite; but they consisted largely of manganese oxide. All gradations between the two exist.

The banded quartzite, which is the ore-bearing layer, is only 30 feet in width, where exposed in the cut; and it is in contact on the

two sides with the residual decay, derived from the mica-schist. Other layers of the rock are exposed lower down the ridge-slope. The ridge soil is several feet deep, and is a deep red ferruginous clay, derived from the mica-schist. It is deepest over the schistic layers; and it only partially covers the harder quartzite layers. The ore is concentrated both along the contact of the quartzite and mica-schist, and in the banded quartzite rock — principally in the latter. Figure 21 shows the mode of occurrence and its relation to the surrounding rocks.

FIG. 29



Section through the Westbrook Tract, Paulding County, Georgia, Showing the Mode of Occurrence of the Ores. A. Mica-schist Partially Decayed and Highly Schistose. B. Banded Quartzite, 30 Feet Wide, Cut by Quartz Stringers Containing the Ore, Which Includes Manganese, Manganiferous Iron and Magnetite.

Lot 997, 20th district, Haralson county, the Westbrook home lot, shows, in the cellar excavation, an exposure of rich garnetiferous mica-schist, in an advanced stage of decay. Adjacent to the garnet areas in the decay, are marked discolorations of both manganese and iron oxides. The small garnet crystals are entirely decomposed. The garnetiferous schist contains no workable manganese; but it is of interest in indicating the possible source of manganese, in certain cases where decay and concentration have reached an advanced stage of development.

Approximately half-a-mile west from the opening on the Westbrook *lot 995*, occurs an extensive body of pyritiferous schist. The rock is a micaceous schist, almost entirely replaced by pyrite. The pyrite was worked continuously for a period of four years, and thousands of tons of the ore were shipped.

THE TOMLINSON PROPERTY. — On *lot 109, 7th district,* Haralson county, a little prospecting work for manganese was done, some years ago. One pit, about fifteen feet deep, was sunk in the red clay, derived apparently from the decay of mica-schist, showing some manganese and iron oxides intimately admixed. The opening was much obscured by caving in at the time of the writer's visit, and showed but little, as to the mode of occurrence of the ore. Nothing of a workable nature was visible.

THE MCPHERSON PROPERTY. — On *lot 150, 7th district,* Haralson county, slight surface indications of manganese appear. The decay is deep-red in color, containing broken fragments of a banded quartzite carrying much magnetite, which, on testing, is manganiferous. No workable ore occurs; and the conditions are quite similar to those described above, on the Westbrook and the Draketown Mining Company's properties.

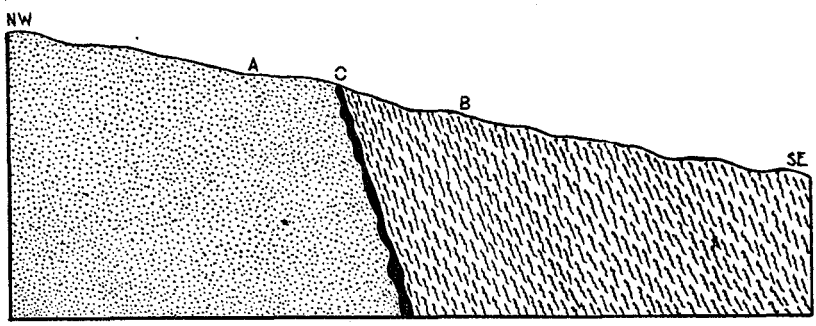
THE STATHAM PROPERTY. — On *lots 906, 914 and 915, 19th district,* Paulding county, a mile and a half east of north from Draketown, some half-dozen openings have been made for manganese on the E. D. Statham place. The openings have a northeast-southwest alignment, and have been made along the contact between mica-schist and a banded quartzite, containing much magnetite. The openings nearest the Statham dwelling are in the nature of shafts worked to a depth of from 20 to 30 feet, from which, it is stated, three carloads of ore were shipped, some years ago.

Manganiferous ore occurs along the banded quartzite-mica-schist contact, and in the hard quartzite rock; but it is not found in the residual clays, derived from the mica-schist. It is admixed with the iron oxides, magnetite and limonite. The ore is partially crystalline and massive, without a trace of the gravel or nodular type indicated. Specimens of the ore-bearing quartzite rock showed, when tested in the laboratory, admixtures of magnetite and manganese

oxide. Also, the separated magnetite, when tested was found to be highly manganiferous. Figures 22 and 23 show the relation of the rocks and the occurrence of the ore on the Statham place.

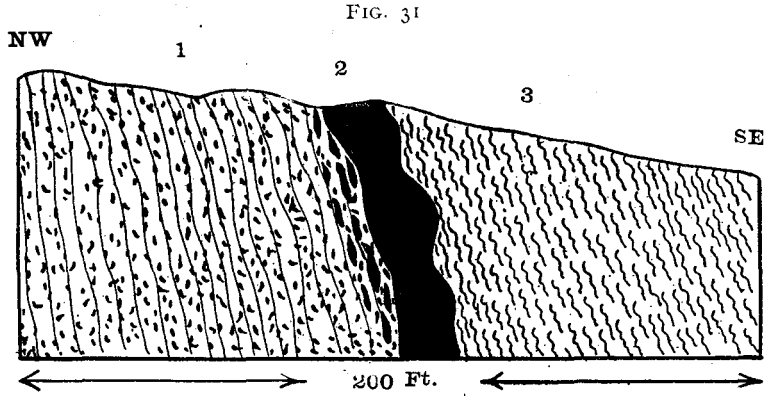
The quartzite rock is usually fine and even-grained and of com-

FIG. 30



Section through the Statham Tract, near Draketown, Georgia, Showing the Mode of Occurrence of the Ores. A. Banded Quartzite with Magnetite and some Pyrite. B. Decayed Mica-schist with the Schistosity Planes Perfectly Preserved. C. Ore, Including Manganese and Manganiferous Iron Ore, Magnetite and Limonite.

FIG. 31



Section Showing the Occurrence of Manganese Ore on the Statham Property, Paulding County, Georgia. 1. Banded Quartzite with Magnetite and some Pyrite, and Manganese-bearing. 2. Ore in Quartzite along Contact of Quartzite with Mica-schist. 3. Partially Decomposed Mica-schist—Garnetiferous in Places away from Openings.

pact texture, and is perfectly banded with magnetite, in varying, but thin layers. It outcrops, as large broken masses and reefs about the openings; and, at times, it contains quite a sprinkling of pyrite. It is narrow in width, and is in contact, on the two sides, southeast and northwest, with extensive areas of mica-schist. The mica-schist is usually garnetiferous; but, in places, garnet is strikingly absent from the schist. Close examination of the garnet in the garnetiferous areas of the schist, showed the mineral, in every case, to be entirely decomposed; and the cavity, originally occupied by the garnet in the rock, is now filled with a mixture of iron and manganese oxides, black or brownish-black in color. At times, the manganese stain extends beyond the area of the original garnet, highly coloring the residual clays derived from the decay of the mica-schist.

THE KIRK PROPERTY. — This property includes parts of *lots 914 and 977, 19th district,* Paulding county, adjoining the Statham tract. Several test-pits have been dug, showing similar conditions as those described above on the Statham place.

Just across the line in Haralson county, on John Mitchell's tract, one mile north of Draketown, one or two prospecting pits have been dug. These indicate some manganese, similar in all respects to that described above.

THE FOLSOM PROPERTY. — This tract, *lot 611, 19th district,* Paulding county, is located about four and a half miles east of Draketown. It does not fall within the limits of the Draketown district, proper, and the manganese found on it is of different character and occurrence from that in the Draketown district. One small pit has been opened on a low knoll forming the divide area between two small branches. The surface of the knoll is thickly strewn with loose angular fragments of white vein quartz, and a few fragments of spongy stalactitic pyrolusite, of good quality. The ore is very limited in quantity, though of excellent quality, similar in every respect to the best grade ore of the Cartersville district. It is dark steel-blue in color, partially crystalline, and concretionary-nodular in form.

The rock, in which the ore occurs, is mica-schist, garnetiferous in

places. It weathers to a deep-red and yellowish-mottled clay, in which the nodules and concretionary masses of the pyrolusite are embedded. The alteration of the mica and garnet of the schist, into a mixture of manganese and iron oxides, is well shown along the slopes of the knoll, in the washes and gullies carved in the decay of the schist. The entire structural features of the original schist are well preserved in the residual clay at every place examined on the lot.

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